EVALUATION OF HOUSEHOLDS SOLID WASTE GENERATION AND DISPOSAL: A CASE STUDY IN EJISU, KWAMO AND FUMESUA IN THE EJISU–JUABEN MUNICIPALITY OF GHANA

BY:

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DECLARATION

I hereby declare that, except for specific references which have being duly acknowledged, this project is my own research and it has not been submitted either in part or whole for any other degree elsewhere.

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DEDICATION

This work is dedicated to my sweet parents Mr. and Mrs. Yankson, my sweet husband Mr. Richard Asare and all my Siblings.

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ABSTRACT

In order to curtail waste management challenges in Ejisu–Juabeng Municipality, a study was conducted in three urban centers within the municipality namely; *Ejisu*, *Kwamo* and *Fumesua*, to quantify the solid waste composition generated at source (houses) and to assess the current disposal methods. The three towns were purposively selected based on the premise of population, histological and commercial activities. Data was gathered through field investigation, survey and face-to-face interviews. Semi–structured questionnaire were administered to households sampled for the research.

The study revealed high levels of putrescible waste in all the three towns. *Ejisu* recorded the highest mean quantity of solid waste generation, followed by *Kwamo* and *Fumesua*, respectively. The mean per capita waste generations in the three towns were 0.2 kg, 0.2 kg, and 0.3 kg per day for *Kwamo*, *Ejisu* and *Fumesua*, respectively, which were all within the national average per capita waste generation of 0.5 kg per day. The influence of socio–economic factors such as household size, income and education on waste generation was not significant.

The study revealed high dependence on communal waste containers as the methods for waste disposal. Waste sorting was not practiced in the study areas. There were inadequate waste containers and skips for the collection of waste and the limited skips available were not emptied regularly which resulted in skips overflow. It was found out that inadequate resources for waste

management institutions to effectively collect and dispose of the waste generated were some of the major factors hindering effective solid waste disposal in the study areas.

In dealing with these challenges, the research recommended possible interventions such as the adequate supply of skips, regular collection of waste and conveying of waste containers on time, proper management of the dumpsite, adequate resourcing of the waste management institutions and public education on sanitation in the study areas.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

KNUST	Kwame Nkrumah University of Science and Technology
UNDP	United Nations Development Programme
UNDESA	United Nations Department of Economic and Social Affairs
UN	United Nation
UNEP	United Nation Environment Programme
LTD	Limited
EJMA	Ejisu-Juaben Municipal Assembly
UK	United Kingdom
EA	Environmental Agency
CED	Center for Environment and Development
KG	Kilogram
MSW	Municipal Solid Waste
W H O	World Health Organization
USEPA	United States Environmental Protection Agency
ISWMS	Integrated Solid Waste Management
MMDAs	Municipal, Metropolitan and District Assemblies"
EC	European Community
EU	European Union
DEFRA	Department for Environment Food and Rural Affairs
US	United State
GTZ	German Agency for Technical Cooperation
MW	Municipal Waste
USD	United State Dollars

CL	Confidence Level
GHp	Ghana Pesewas
GH¢	Ghana Cedis
GH	Ghana
GPC	Generation Per Capita
KMA	Kumasi Metropolitan Assembly
AMA	Accra Metropolitan Assembly

CHAPTER ONE

INTRODUCTION

1.1 Background

Solid waste management is an important facet of sustainable development for any nation and has been greatly supported by global initiatives. For instance, Agenda 21, the Rio Declaration on Environment and Development, clearly affirmed that, environmentally sound management of wastes was an environmental issue of major concern in maintaining the quality of Earth"s environment and in achieving environmentally sound and sustainable development in all countries (UNDESA, 2005). Sustainable solid waste management was again supported by the United Nations Millennium Development Goals (MDGs), adopted by 189 countries and signed by 147 heads of state and governments during the UN Millennium Summit in September 2000 (UN Millennium Declaration 2000). However, efforts directed at enhancing solid waste management are usually inefficient and unproductive, especially in Ghana. The World Health Organization(WHO) had reported of three billion people in developing countries lacking safe sanitation as at the year 2010 and had predicted that, within 20 years an additional two billion people mainly in towns and cities in developing countries would demand safe sanitation (WHO, 2010: cited by Uruma *et al.*, 2012). For instance, it was estimated that, 82% of Ghanaians lack access to improved sanitation (Bensah et al 2010). In this regard, the millennium development goals target ten (10) was proposed to half the proportion of people without suitable access to basic sanitation and safe drinking water by 2015 (WHO, 2010: cited by Uruma *et al.*, 2012). Solid waste (SW) over the years has constituted massive challenge for local governments due to its constant increase and changes in its constituents. Moreover majority of the municipalities have limited

records on waste generation, its origin and characteristics (Taboada-González *et al*, 2010) as the case in Ghana. This inadequate information causes the decisions regarding proper solid waste management to be centred on assumptions and inferences, which has resulted in its inappropriate management with serious consequences for the environment (Buenrostro and Bocco, 2003). For instance, plastic bags used and disposed of by consumers and through waste management activities, not only create environmental problems, but also reinforce the perception of a wasteful society (Akoaso, 2012). It is therefore necessary to know the basic qualitative and quantitative characteristics of solid waste as its increase requires alternatives of handling and treatment (Papachristou, *et al.* 2009). Lack of appropriate planning, inadequate governance, resource constraint, and ineffective management of solid waste especially insufficient collection and improper disposal of waste has been a major concern for many rapidly growing cities in developing countries such as Ghana (Medina, 2010). The difficulty of solid waste management is a major source of concern in Africa and has been identified as one of the major challenges in the promotion of sustainable production and consumption in the region (Adewumi, 2006).

Ghana is highly challenged in the areas of solid waste collection and location of dumpsites. While towns and cities develops as a result of increase in population and socio-economic activities there has not been a corresponding increase in essential facilities, logistics and personnel for effective and efficient waste management in the country (Agyepong, 2011). The improper location of dumpsites has sparked numerous complaints by residents about the unbearable stench from refuse dumpsites located close to settlements. The Daily Graphic news agency recently carried a story on this issue about *Abokobi*, a suburb in Accra (Daily Graphic

Feb. 4, 2013). Poor sanitation costs the country (Ghana) GH¢ 420 million annually, which is equivalent to US$ 290 million because of sanitation related diseases (WSP, 2011). The generators who are supposed to be stakeholders in waste management are often left out in decisions regarding waste management. Edmunson (1981) had reported on not considering the distances covered by inhabitant in accessing disposal facilities in the planning and positioning of solid waste facilities. The long distances inhabitants travel to access disposal facilities and inadequate solid waste management facilities has contributed to the indiscriminate disposal of waste in open dump site, gutters and backyards of houses and even in water sources.

The deficiencies in handling solid waste problems in the country has generated public attention where different opinions are given on the issue daily during radio and television discussions. According to the United Nations Environment Programme (UNEP, 2004), in many rapidly growing cities, solid waste is a major concern due to weaker waste management strategies and resource constraints. Johannessen and Boyer (1999) had also reported that, the design and optimization of solid waste management technologies and practices that aim at maximizing the yield of valuable products from waste as well as minimizing the environmental effects have had little or no consideration in the African Region. This gives the countries in the region the choice to at least channel their effort and concentrations on a more effective and efficient collection and disposal methods. Solid waste generation, its collection and disposal are functions of several factors which could be socio-economic, weather and climatic, demography and many others (Mensah , 2008). These factors if appropriated could result in desired solution to the solid waste management problems in developing countries especially Ghana.

1.2 Problem Statement

Waste disposal is one of the major challenges confronting the waste management companies in Ghana. Even though extensive studies have been conducted on waste generation and disposal in some cities in Ghana (Achankeng, 2003; Fredua, 2004), only about 55% of the solid waste generated is collected. The rest are dumped indiscriminately causing health and environmental problems (Achankeng, 2003). Very little waste generation and disposal studies have been done in the peri-urban areas. This leaves the sanitation authorities in most urban centres with limited information to properly plan its operations and to effectively manage solid waste. For purposes of urban development planning, the amount and kind of solid waste that is generated at source (homes) must be known. It is envisaged that for proper integrated solid waste management to be put in place, the characteristics of the solid waste generated must be known (Sakai *et al.* 1996).

Ejisu, *Fumesua*, and *Kwamo* are among the five vibrant urban and commercial towns in the Ejisu–Juaben Municipality. The peri-urban nature of the settlements in these towns has provided opportunity for people looking for low cost accommodation resulting in the influx of migrants to these areas. The towns are serving as destination points for immigrants due to their closeness to the Kumasi metropolis. Additionally, these towns are located along the Kumasi–Accra highway which provides good transportation accessibility to settlers who easily commute to work in Kumasi and the surrounding areas. The influx probably has caused an increase in population in the towns making them the fastest growing towns in the municipality (Population Census, 2010). The accompanying increase in economic activities in the towns coupled with historic and cultural heritage of the towns make sanitation an important issue to consider in keeping the towns clean.

Efficient, effective and adequate solid waste management in these towns then becomes necessary to ensure clean environment in order to promote public health and sustainable development.

Waste collection and disposal in these towns are managed by Zoom Lion Company Limited which is a private waste management company in Ghana. A cursory look at the towns shows certain areas littered with refuse and refuse containers overflowing. Efforts have been made by Zoom Lion Company Limited to improve sanitation in the towns by positioning skips at vantage points to collect refuse from households and other commercials centres at GHp 10 and GHp 20 per head load depending on assumed weight. However, facilities for solid waste collection services are inadequate and people are not willing to pay for the collection services. Additionally, waste management in Ghana has been poorly financed; funds for the operation of urban waste management services are mainly from the central government and donors (Liyala, 2011). The problem is compounded by the inability and sometimes the unwillingness by the urban community to pay for waste collection services to enable management to accrue enough funds to manage the waste. Therefore this project seeks to identify and quantify solid waste generated within these three towns and to assess and evaluate the current waste disposal methods.

1.3 Research Hypothesis

People`s attitudes, inadequate resources, equipment and personnel, and deficiencies in management strategies affect the effectiveness and efficiencies of solid waste management in *Ejisu*, *Fumesua* and *Kwamo* in the Ejisu-Juaben Municipality.

1.4 Aim and Objectives

The study is aimed at quantifying solid waste generated in *Ejisu*, *Fumesua* and *Kwamo* and to assess its disposal methods.

Specifically the study seeks to;

1. Identify the types and composition of solid waste generated at source of generation

   (houses) in the study areas.

2. Determine per capita solid waste generation in the study areas.
3. Assess the current methods of solid waste disposal in the study areas.
4. Make recommendations for improvement in waste management.

1.5 Justification

One of the most accurate approaches for characterizing waste composition consists of collecting waste at its generation source and directly sorting it out into types of materials (Brunner and Ernst 1986; Martin *et al.* 1995). Although extensive work has been conducted on solid waste generation and disposal in Ghana, there is no such work conducted in the study areas. Additionally, there are limited published works on solid waste generation in Ghana focusing on source specific quantification of household solid waste. Specific quantification and characterization of solid waste generated assumes great significance which will enable accurate assessment of waste load and encourage proper planning of solid waste management system. This would help in achieving proper solid waste management and utilization of reusable resources in the study areas. For instance, most of the municipal solid wastes are putrescible and therefore the properties of this kind of solid waste are affected during storage, collection and transportation processes. Thus,

characterizing this kind of waste at transfer stations would not give actual values. It is also reported that municipal solid waste generation rate could be affected by socio-economic factors. This could be effectively investigated when solid waste quantities and composition are conducted at source of generation. Assessment of all the elements involved in solid waste management is necessary to the identification of deficiencies that exist in the existing management strategies in the study areas and enable a change or restructuring in the management system.

1.6 Scope and Limitations

The study focuses on municipal solid waste collection and disposal systems and was limited to *Ejisu*, *Fumesua* and *Kwamo* municipal areas. The study is therefore primarily limited within the boundaries of the three towns. The conceptual dimension brings to the front the involvement of people which may not necessarily be in the towns but are stakeholders in waste management in the municipality. The research could not be carried out co-currently in the towns due to inadequate funding and personnel to assist in the work.

1.7 Thesis Structure

The thesis is divided into six different Chapters. Chapter One gives the introduction of the thesis giving the background, problem being addressed, aim and objectives, justification of the objectives, and the scope and limitations of the study.

Chapter Two is the literature review and defines waste and solid waste in contest, types and sources of solid waste and solid waste management and the current international and national trends and issues which have a link with the study. The review seeks to find out the benefits of effective and efficient solid waste management in the context of the environment, social and economic. The

factors that affect solid waste management are reviewed as well as the establishing their influences on waste management.

Chapter Three outlines the method and materials used in the study. The sampling method and limitations to the study are also captured under this section. In Chapter Four the results obtained from the field measurement, observations and interview are presented and discussed. Chapter Five presents the key findings of the research and proposed recommendations for improvement.

CHAPTER TWO

LITERATURE REVIEW

2.1 Definition of Waste

Waste is something that is no longer useful to the owner or when that item is used but fails to fulfil its purpose of use (Gourlay, 1992). Waste are substances or objects which are disposed or intended to be disposed or are required to be disposed of by the provisions of national laws (Basel Convention, 1997). Many items can be considered as waste e.g. rubbish, sewage sludge, wastes from manufacturing activities, packaging items, discarded cars, old televisions, garden waste, old paint containers among others. However, definition of waste could be subjective in that an item that is considered waste by an individual; to another person could be a resource. For instance, items that are considered waste in developed countries find their way in developing countries where they are reused. Examples of waste are electronics equipments such used refrigerators, computers, televisions, and cooking wares and used clothing"s. Among all sources of solid waste produced, residential domestic waste forms the bulk of them in urban areas (Benneh *et al*., 1993).

These household wastes are known to have high densities with high moisture content and about 70% – 90% organic component while tins, cans and paper may be responsible for about 5% to 10% of the total waste, produced (Benneh *et al*., 1993).

2.2 Definition of Solid Waste

The term solid waste has been defined differently by different writers. Tchobanoglous *et al* (1993) defined solid waste as any material that arises from human and animal activities that are normally regarded as useless or unwanted. Conversely, solid waste has also been defined by Zerbock (2003)

as non-hazardous industrial, commercial and domestic waste including household organic trash, street sweepings, and institutional garbage and construction wastes. The UK Environmental Agency classifies solid waste as either controlled waste or non-controlled waste (UK E.A, 1999). Controlled waste includes waste from households, commercial centres, and industrial sources and from construction and demolition. Non-controlled wastes are waste from agriculture, mines and quarries and from dredging operations. It is reported that household solid waste is one of the most difficult sources of solid waste to manage because of its diverse composite nature (Huntly, 2010). Household solid waste include plastics, paper, glass, textiles, cellophane, metals and some hazardous waste from household products such as paints, garden pesticides, pharmaceuticals, fluorescent tubes, personal care products, batteries containing heavy metals and discarded wood treated with dangerous substances (White and Franke, 1995).

2.3 Types and Sources of Solid Waste

Tchobanoglous *et al* (1993), classified types of solid waste in relation to the source of generation, generation facilities or activities, and locations. However, the Centre for Environment and Development (2003) classified types of solid waste based on their origin as food waste, rubbish, ashes and residues, demolition and construction, and agriculture waste. The centre also classified solid waste based on their biological characteristics as biodegradable (waste that easily decomposes and non-biodegradable waste (waste that does not decompose). Also types of solid wastes could be classified based on the risk potentials associated with the waste as hazardous waste and non–hazardous waste.

The centre also indicated sources of solid waste as residential waste thus, waste from shops, commercials establishment, hotels, restaurants, eating stalls, slaughter houses and others. Food wastes; waste from animal, plant or vegetable residues resulting from the handling, preparation, cooking, and eating of foods. The most important characteristics of these waste is that, they decompose rapidly usually producing offensive odours especially in warm climate. The putrescible nature of these wastes considerably influences the design and operations of solid waste collection systems in various localities (CED, 2003).

2.4 Components of Solid Waste

Solid waste consists of many different materials. Some are combustible, non-combustible, recyclable, non-recyclable, biodegradable, and non-biodegradable. Essentially, detailed documentation of the composition of solid waste will specify the management methods to be employed (Zerbock, 2003). The combustible materials that may be included in a waste stream include paper, plastics, yard debris, food waste, wood, textiles, disposable diapers, and other organics and the non-combustibles materials also include glass, metal, bones, leather and aluminum (Denison and Ruston 1990; Kreith, 1994 and Zerbock, 2003).

Activities involved in solid waste handling can influence its composition. For instance in Vientiane, 18 to 30% of wastes generated are sold and recycled making the composition of wastes collected by waste pickers and those found in the dump site different (http://www5.gtz.de/gate/publications/BiogasDigestVol1.pdf). Research has indicated that, the largest stream of municipal solid waste in Indonesia flows from households followed by traditional markets (Aye and Widjaya, 2006). According to Mizpah *et al*., (2009), the composition of solid

waste in Kumasi, the second largest city in Ghana after Accra the capital, is predominantly made of biodegradable materials and high percentage of inert materials which include wood ash, sand and charcoal.

Benneh *et al.* (1993) also observed that, residential domestic waste forms the bulk of all sources of solid waste produced in urban areas. These household wastes are known to have high densities with high moisture content and the organic component of solid wastes, which properly accounts for about 70% to 90%, while tins, cans and paper are probably responsible for about 5% to 10% of the total waste produced. According to a research by Fobil (2000), the per capita of plastic wastes generation in Ghana, stood at 0.016 – 0.035 kg/person/day, and plastics make up between 8–9% of the component materials in the waste stream. Now most products are packaged in polyethylene films, which form about 70% of the plastic waste in the municipal waste stream. The changes in relative shares of different constituents of plastic wastes in the waste stream in the past several decades can largely be attributed to changing lifestyles and increasing consumerism (Bhide and Sundaresan, 1983; Fobil, 2000).

2.5 Solid Waste Management

Solid waste management could be defined as all the activities involved in the administration that provide for the collection, source separation, storage, transportation, transfer, processing, treatment, and disposal of waste". However, Tchobanoglous *et al.*, (1993) defined solid waste management as "that discipline associated with the control of generation, storage, collection, transfer and transport, processing and disposal of solid wastes in a manner that is in accordance with the best principles of public health, economics, engineering, conservation, aesthetics and other

environmental considerations and also responsive to public attitudes". Consequently, if solid waste management is to be accomplished in an efficient and systematic manner, the fundamental aspects and relationships involved must be indentified and understood clearly (Tchobanoglous *et al*, 1993). On this premise, the activities involved in solid waste management must be critically examined and understood before execution and must be handled by an expert in the field. These activities include source separation, storage, collection, transportation and disposal (Tchobanoglous *et al*, 1993).

2.5.1 Waste sorting

Waste sorting is the process by which waste is separated into different elements. Waste sorting can be done manually at the household level and/or done using automatic separator of materials at recovery facilities or mechanical biological treatment systems. All aspect of human activities generates several unwanted materials such as food waste, newspapers, broken bottles, aluminium cans, yard trimmings, etc. Waste sorting is an important procedure in recycling and treatment of waste material. Waste collection and its subsequent sorting play a vital role in waste management system because it is a determinant for the feasibilities of recycling and composting.

Separation operations have been devised to recover valuable resources from the mixed solid wastes delivered to transfer stations or solid waste processing plants (Tchobanoglous *et al*, 1977).

In Ghana, sorting of solid waste is not commonly practiced (Abagale *et al*., 2012).

2.5.2 Waste storage

Tchobanoglous *et al*., (1977) explained storage to mean where solid waste is temporarily stored before it is collected and disposed. Storage is of primary importance because of aesthetic consideration as well as public and environmental health issues. Waste storage containers are

usually made of metals or plastics. Common terms used for waste containers are dustbins, garbage cans, litter bins, rubbish bins, bin trash and rubbish barrel. However other people also store their waste in all kinds of facilities such as sacks, polythene bags, plastics, metal buckets and baskets (Fredua, 2004).

2.5.3 Waste collection

Waste collection could be described as the contact point between waste generators and waste management system; this crossing point requires careful management (Anomanyo, 2004). Household solid waste collection has been describe by Read (2003) as an interface just like a customer- supplier relationship in which the householder"s solid waste must be collected with a minimum of inconvenience and the collector must also be given the waste in a form well-suited with intended treatment methods of the waste. The element of collection includes not only the gathering of solid waste, but also the hauling of waste after collection to the location where the collection vehicle is emptied (Kreith, 1994). The commonest waste collection practice in Ghana is where solid waste is received directly into waste container (skips) from households and commercial establishments and in some cases plastic and metal bins are positioned by the roadsides which are woefully inadequate (Puopiel, 2010). According to Tsiboe and Marbel (2004), three basic methods of household waste collection exist in Accra as the case in many of the MMDAs in Ghana where either, one, two or all the three methods are employed in waste collection. The methods are door-to-door collection services, waste collection by waste management department (WMD) and curbside waste collection by WMD using trucks which
stop directly outside each house to receive their waste.

According to Anomanyo (2004), solid waste collection in the city is carried out both on franchise and contract basis. On the contract basis, a house-to-house waste collection is provided in high income areas where contractors provide plastic waste bins with covers to houses and charge fees with weekly collection frequency. With the use of communal waste containers, residents do not pay user charges when they deposit their waste in the containers. The containers are collected at least once daily. According to Anomanyo (2004), in spite of strategies put in place for waste collection in Accra, between 65 and 75% of waste was collected daily.

In the Kumasi Metropolis two modes of waste collection exist. These are house-to-house and communal collection. According to Metropolitan Assembly, the door-to-door collection was on franchise basis for a monthly fee of GH¢6 to GH¢10 per house depending on the size of waste container whiles the communal collection costs GHp 20 per head load. The use of the communal container mode of waste collection may attract minimal collection and therefore there is the tendency of poor waste collection services in the areas this system exist. There is the likelihood for residents to dump waste any how because of poor collection service.

2.5.4 Waste transfer and transport

Wastes produced go through a process of transfer and transport before it reaches the final disposal site. Wastes collected at one location are transported by tricycles, vehicles, trains and ships to another location for either processing or deposal. The transportation of solid waste has a wide range of environmental and social effects in urban areas such as air pollution, the deposit of dirt and waste on roads and contribution to traffic congestion. As suggested by Kreith (1994), waste transfer and transport involves two steps: (1) the transfer of wastes from the smaller collection

vehicle to the larger transport equipment and (2) the subsequent transport of the wastes, usually over long distances to the final disposal site. The collection, transfer and transport of waste have become massive challenge to many developing countries. For instance, in Kampala city - Kenya out of 1600 tonnes of solid waste generated per day, 45-50% of the tonnes rot uncollected (Niringiye and Douglason, 2010).

2.5.5 Waste disposal

Several methods of solid waste disposal have evolved over the years. These methods according to the Centre for Environment and Development (2003) vary greatly with types of wastes and local conditions. According to Tchobanoglous *et al.*, (1993), the most commonly recognized methods for the final disposal of solid wastes were; dumping on land, canyons and mining pits, dumping in water, ploughing into the soil, feeding to hogs, reduction and incineration. Some of these unhealthy practices of solid waste disposal still exist in certain cities, towns and villages today. Indiscriminate dumping on opened land and dumping in gutters are very obvious in towns and cities while people living in coastal towns use water sources as dumping site. Burning of refuse dump is also common in peri-urban and rural communities in Ghana and in other less developed countries (Puopiel, 2010). According to the deputy director of the waste management department of KMA, Mr. Kotoka (Personal communication, 2013) there is a well-engineered sanitary site at Dompoase where wastes collected are compacted and covered. Wastes to the site are inspected and weighed before dumping.

2.6 Solid Waste Processing and Recovery

Modern waste management is shifted to a more flexible waste hierarchy concept, also known as 3R s (reduce, reuse, recycle) policies (Tanaka, 1999). Some of the existing methods of solid waste processing and recovery include composting, source reduction, disposal at sanitary landfills, recycling and incineration (Denison and Ruston, 1990).

2.6.1 Composting

Composting process uses microorganisms to degrade the organic content of the waste. Aerobic composting proceeds at a higher rate and converts the heterogeneous organic waste materials into homogeneous and stable humus (CED, 2003).

2.6.2 Source reduction

Waste reduction may occur through the design, manufacture, and packaging of products with minimum toxic content, minimum volume of material, and/or a longer useful life. Waste reduction may also occur at the household, commercial or industrial facility through selective buying patterns and the reuse of products and materials (USPS, 2000). Recycling programs certainly reduce the quantities of wastes collected for further processing or disposal (Tsiboe and Marbel, 2004). Research had shown that, 80% of Americans reuse plastic products, such as food storage containers and refillable bottles. In the United States, nearly 50% of certain plastic parts from damaged or discarded cars are repaired and reused (Stanitski *et al*., 2000).

2.6

.3 Disposal at sanitary landfill

Sanitary land filling includes confining the waste, compacting and covering it with soil. It not only prevents burning of garbage but also helps in reclamation of land for valuable use (CED, 2003). The placement of solid waste in landfills is the oldest and definitely the most prevalent form of ultimate waste disposal (Kreith, 1994; Zerbock, 2003). According to Zerbock, (2003), the difference between landfills and dumps sites is the level of engineering, planning, and administration involved. Open dumps are characterized by the lack of engineering measures, no leachate management, no consideration of landfill gas management, and few, if any, operational measures such as registration of users, control of the number of "tipping fronts" or compaction of waste.

2.6.4 Recycling

Recycling has been seen as a means of minimizing the amount of household solid wastes that goes to dump sites (Kreith, 1994; Momoh and Oladebeye, 2010). Recycling also provides the needed raw materials for industries. Accordingly, it is established that, it is the best, effective and efficient method of solid waste management system. According to USEPA, recycling turns materials that would otherwise become waste into valuable resources and, it yields environmental, financial, and social returns in natural resource conservation, energy conservation, pollution preventions, and economic expansion and competitiveness (USEPA, 1999).

.5 Incineration of solid waste

Incineration is a waste volumetric reduction process that relies on combustion under controlled conditions to reduce the volume and/or mass of material for disposal. This process occurs in an

2.6

incinerator, a furnace for burning waste. Incineration of waste materials converts the waste into ash, flue gas, and heat. The ash is mostly formed by the inorganic constituents of the waste, and may take the form of solid lumps or particulates carried by the flue gas. The flue gases must be cleaned of gaseous and particulate pollutants before they are dispersed into the atmosphere. In some cases, the heat generated by incineration can be used to generate electric power. Incineration may also be implemented without energy and materials recovery. Incinerators have the capacity to reduce the volume of waste considerably, up to nine fold than any other method (Kreith, 1994). However, the main constraints of incineration are high cost of operation, relatively high degree of sophistication needed to operate them safely and economically as well as the tendency to pollute the environment through emissions of carbon dioxide. In several countries, there are still concerns from experts and local communities about the environmental impact of incinerators.

2.7 Solid Waste Generation Rate

It is important to know the amount of waste generated and the composition of the waste stream in order to develop an effective and efficient waste management strategy for a given location. Different researches have publicized the proportionality between the amount of waste generated by a country to its population and the mean living standards and have related waste generation rates to income levels of populace (Medina, 1997). However, it has also been established that, other socio-economic factors can influence solid waste generation and these include household

size, cultural patterns, education and personal attitudes (Al-Momani, 1994). However, the relationships between various parameters may vary from country to country and this has been attributed to variations in consumer behaviour and lifestyles (Afroz *et al*., 2010). For instance, according to Afroz *et al* (2010) in Bangladesh the average monthly household income was about US$ 176 and the averaged waste generation was 38 kg/month/household. For a household averaged 4 members, the per capita waste generation averaged 0.3 kg/day. They also reported of a positive correlation between income and household size and Education and waste generation. However, the relationship was not significant. The same findings have been established by other researchers in other countries (Hong and Adams, 1999; Fullerton and Kinnaman, 1996).

A study by Tam and Tam (2008) revealed that, reward schemes and incentive systems contribute to employee awareness and motivation regarding waste reduction, and reduce waste by 23%. According to Agbola (1993), cultural derivatives, beliefs, perceptions and attitudes are learned response sets and can therefore be modified or changed through education. According to Pacey (1990), formal education for women is a pre-requisite for change in sanitation behaviour.

According to Mensah and Larbi (2005), based on an estimated population of 22 million and an average daily per capita waste generation of 0.45 kg, Ghana generated about 3.0 million tonnes of solid waste annually. Reports indicate that solid waste generation in Accra was between 1500 – 1800 tonnes daily with an average estimated per capita waste generation of 0.5kg (Anomanyo, 2004; Boateng and Nkrumah, 2006). The waste from domestic sources included food waste, garden waste, sweepings, ash, packaging materials, textiles and electric and electronic waste with organic waste being the main component which constituted about 65%. Anomanyo (2004) also

reported that, the high proportion of organics in the waste stream was due to the country`s high dependency on agricultural products for both export and domestic consumption. According to Kotoka (2010), the domestic waste generation rate in Kumasi metropolis is approximately 1500 tonnes a day with per capita generations of 0.5 kg and GH¢ 8 million expenditure on waste management annually. Ketibuah et al (2010) also found bulk of household waste to be organic, constituting an average of 55% in their research in Kumasi.

2.8 Challenges in Solid Waste Disposal

According to UNEP (2009), World Bank estimated that, it is common for municipalities in developing countries to spend 20 to 50% of their available budget on solid waste management, even though 30 to 60% of all the urban solid wastes remain uncollected and less than 50% of the population is served. The programme suggested that if most of the waste could be diverted for material and resource recovery, then a substantial reduction in final volumes of waste could be achieved and the recovered material and resources could be utilized to generate revenue to fund waste management. Establishing effective municipal solid waste management should be a priority for emerging cities, given their crucial role in protecting public health and the environment. However, in the past, most attempts by cities to improve solid waste management focused on the different technical means of collection and disposal (World Bank 1992; Alta and Deshaz 1996). According to Ogawa (2005), a typical solid waste disposal system in a developing country displays an array of problems, including low collection coverage and irregular collection services, crude open dumping and burning without air and water pollution control. For instance, the AMA since 1991 has been battling with land for disposal sites and has been changing dumpsite ever since (Anomanyo, 2004). He additionally added that since the previous systems of solid waste disposal

could not compete with the increasing quantity of solid waste being generated in Accra, the public employed various means of waste disposal. Wastes were consequently disposed indiscriminately especially in watercourses and drainage channels and also through burning.

2.9 Solid Waste Disposal in Ghana

Solid waste disposal has become a major challenge to Municipal, Metropolitan and District Assemblies (MMMDAs) in Ghana due to urbanization and increasing population in several cities and towns. Metropolitan Assemblies find it difficult to deal with the huge volume of solid waste generated on daily basis. Indiscriminate dumping that has been adopted by the people as a means of waste disposal has resulted in littering and heaping of refuse in many urban centres in the country. Abrokwah (1998) observed that ignorance, negligence, lack of law to punish sanitary offenders, and low level of technology in waste management are the major causes of waste management problems in the Kumasi Metropolis. The country has made little effort towards integrated solid waste management which implements the 3Rs principle. However, research has shown that waste management strategies that focus on source reduction, resource recovery and reuse (3Rs) have proven to be more cost effective over the long run, and are less damaging to the environment because they prevent or minimize waste generation at the source (Cheremisinoff, 2003).

Many factors may influence waste management. Some of these factors could be religious, cultural beliefs, gender and generational differences (Mongolnchaiarunya, 2005). The socioeconomic status of the workers of waste management system is typically, very low. People who belong to the economically rich group believe that their littering practice is the right thing, because it offers

employment for people (Mongkolnchaiarunya, 2005). While ascertaining the support and participation of the community for a shift in the waste management system the socio-cultural attitudes of the population towards wastes and their attitudes to gender roles relating to waste management in and outside their homes; their openness to integrated approaches involving recycling and composting; their ability and willingness to pay for an improved waste management system must be considered.

(http://www5.gtz.de/gate/publications/BiogasDigestVol1).

2.10 Waste Management Policy and Regulations in Ghana

In Ghana, the Ministry of Local Government and Rural Development (MLGRD) is responsible for sanitation and general waste management in the country. The Ministry (MLGRD) supervises the decentralized Municipal, Metropolitan and District Assemblies (MMDAs). However, regulatory authority is vested in the Environmental Protection Agency (EPA) under the auspices of the Ministry of Environment, Science and Technology. The Metropolitan, Municipal and District Assemblies are responsible for the collection and final disposal of solid waste through their Waste Management Departments (WMDs) and their Environmental Health and Sanitation Departments (EHSD). Several legislations and policies have been instituted in the country that serves as framework guiding waste management in Ghana. These include the Local Government Act (1994), Act 462, the Environmental Sanitation Policy of Ghana (1999), the Environmental Protection Agency Act (1994), Act 490, the Pesticides Control and Management Act (1996), Act 528, the Environmental Assessment Regulations 1999, (LI 1652), the Guidelines for the

Development and Management of Landfills in Ghana, and the Guidelines for Bio-medical Waste (2000). All these Acts and Regulations were derived from the National Environmental Action Plan (MLGRD, 2004).

The National Environmental Sanitation Policy looks at the basic principles of environmental sanitation, problems and constraints. The role and responsibilities are assigned to all stakeholders in waste management. The policy also indicates legislations and criteria for specifying services and programmes, funding, equipment and supplies for efficient waste management. Out of the National Sanitation Policy, the MLGRD has also developed a technical guideline document titled „The Expanded Sanitary Inspection and Compliance Enforcement (ESICOME) Programme Guidelines". The programme guidelines which are implemented by the MMDA"s, routinely looked at four broad areas namely; effective environmental health inspections (Sanitary Inspections), dissemination of sanitary information (Hygiene Education), pests/vector control and law enforcement. All MMDAs are supposed to develop waste management and environmental health plans to help solve the various sanitation problems. Generally, the National Environmental Sanitation Policy Co-ordination Council (NESPCC) is responsible for coordinating the policy and ensuring effective communication and cooperation between the many different agencies involved in environmental management in their respective Districts (MLGRD, 2004).

The local government Ministry also in collaboration with the Ministry of Environment, Science and Technology, EPA and the Ministry of Health have prepared several guidelines and standards for waste management in the country including National Environmental Quality Guidelines

(1998), Ghana Landfill Guidelines (2002), Manual for the preparation of district waste management plans in Ghana (2002) and Guidelines for the management of healthcare and veterinary waste in Ghana (2002). In spite of the numerous sanitation regulations and policies that have been put in place by the government to deal with the solid waste menace in the country, there has not been correspondent improvement in solid waste management.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The study was conducted in Ejisu-Juaben Municipality in the Ashanti region of Ghana. The methods used in this study to collect data were field measurement, interviews with structured questionnaire, personal communication and observations. The field observations generally served to validate the reality of the data gathered through the interviews.

3.2 Description of the Study Area

The study was conducted in *Ejisu*, *Fumesua* and *Kwamo* in the Ejisu-Juaben Municipality as shown in Figures 3.1 and 3.2. The area lies within Latitudes 1º 15‟N and 1º 45‟N and Longitude 6º 15‟W and 7º 00 W, occupying a land area of 637.2 km^2.The municipality has experienced drastic population increase over the last decade, a phenomenon that has changed the typical rural Ejisu-Juaben District into a fast growing peri-urban Ejisu Juaben Municipality. The current rural/urban divide is estimated to be in the ratio of 60%:40%. For instance, the 2000 National Population and Housing Census put the population of the Municipality at 124,176 comprising 59,286 males and 64,890 females with an average 1984 – 2000 inter - censual growth rate of 2.5%. It was predicted from the 2009 estimated population of 155,270 that, by 2013 the municipality would have an estimated population of 189,744. The population trend in the study areas is summarized in Table 3.1.

Table 3.1: Population trend in the study areas

Town	Population in Census Year		
	1984	2000	2010 (Estimate)
Ejisu	5133	10923	14016
Kwamo	1764	5470	6472
Fumesua	1518	4576	5872

The municipality had a relatively high population density of 195 km^2 in the year 2000 that made it the sixth most populous area in the Asante region. This is because the municipality has become a "dormitory" of the Kumasi metropolis as large number of people live in the municipal area but commute to Kumasi to work. The municipal area has 84 settlements out of which 5 are classified as urban settlements (Population Census, 2000). Among these are the three studied areas; thus *Ejisu, Fumesua and Kwamo*. The five towns accounted for 30.1% of the total population. Currently, *Ejisu* has female population of 9,967 and male population of 8,424. *Fumesua* and *Kwamo* have female population of 4,002 and 3,243 and male population of 3,674 and 3,010, respectively. The average household size in Ejisu-Juaben municipality is 4.5 (Population Census, 2010).

Agriculture is the main economic activity in the municipality. The topography of the area is generally undulating, dissected by plains and slopes with heights ranging between 240 meters and 300 meters above sea level. The area has bi-modal rainfall pattern. The major rainfall period begins from March to July peaking in July. The average annual rainfall for the major season is about 1200 mm – 1500 mm per year. The minor rainfall period begins in September and tapers off in November with an average minor annual rainfall of 900 mm – 1120 mm per year. Mean annual

temperatures in the Municipal area are lowest around 25ºC in August and highest around 32º C in March. The area lies in the semi–deciduous forest zone of Ghana (ghanadistricts.com).

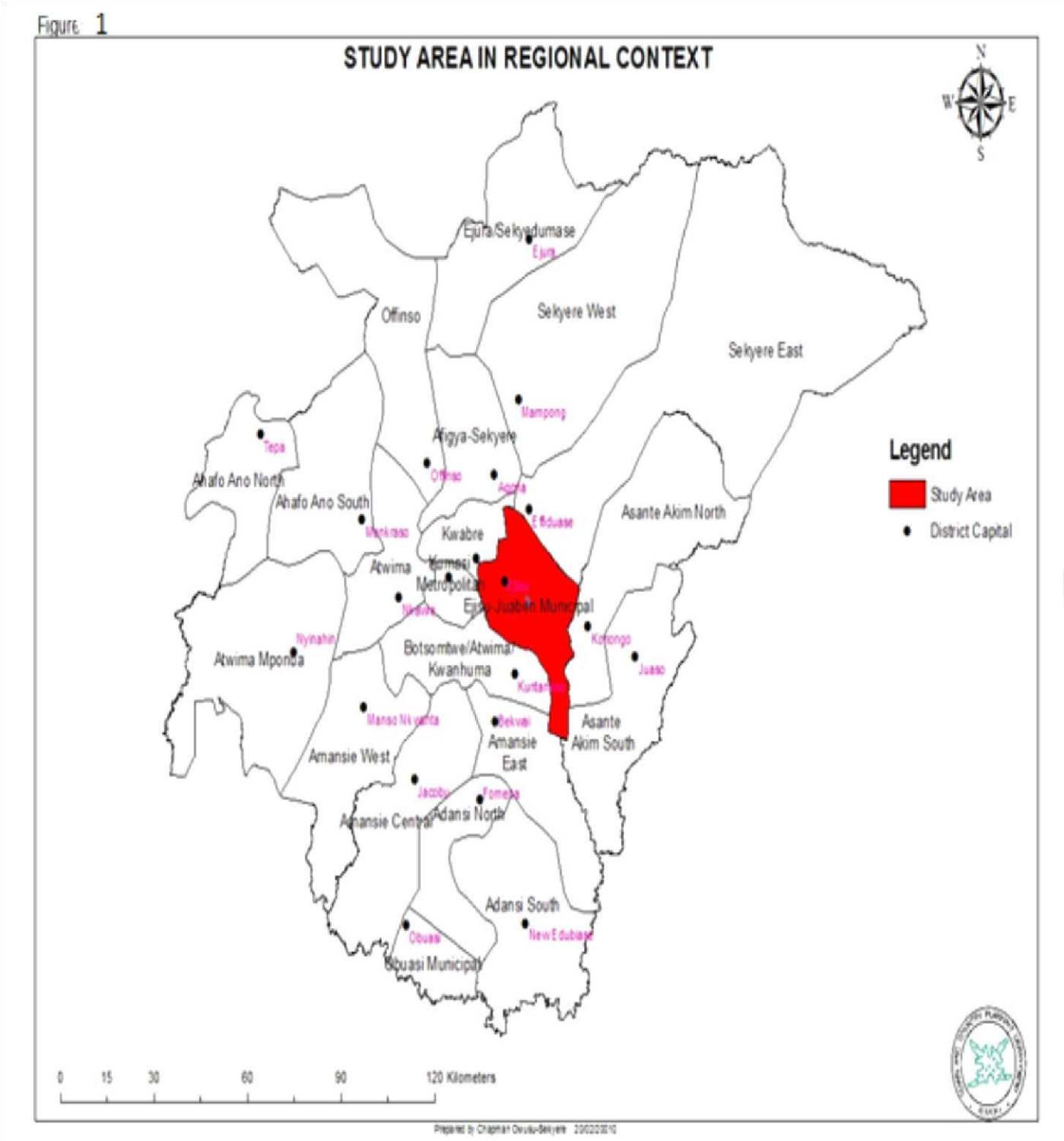

Figure 3.1: Map showing the study area in Regional context.

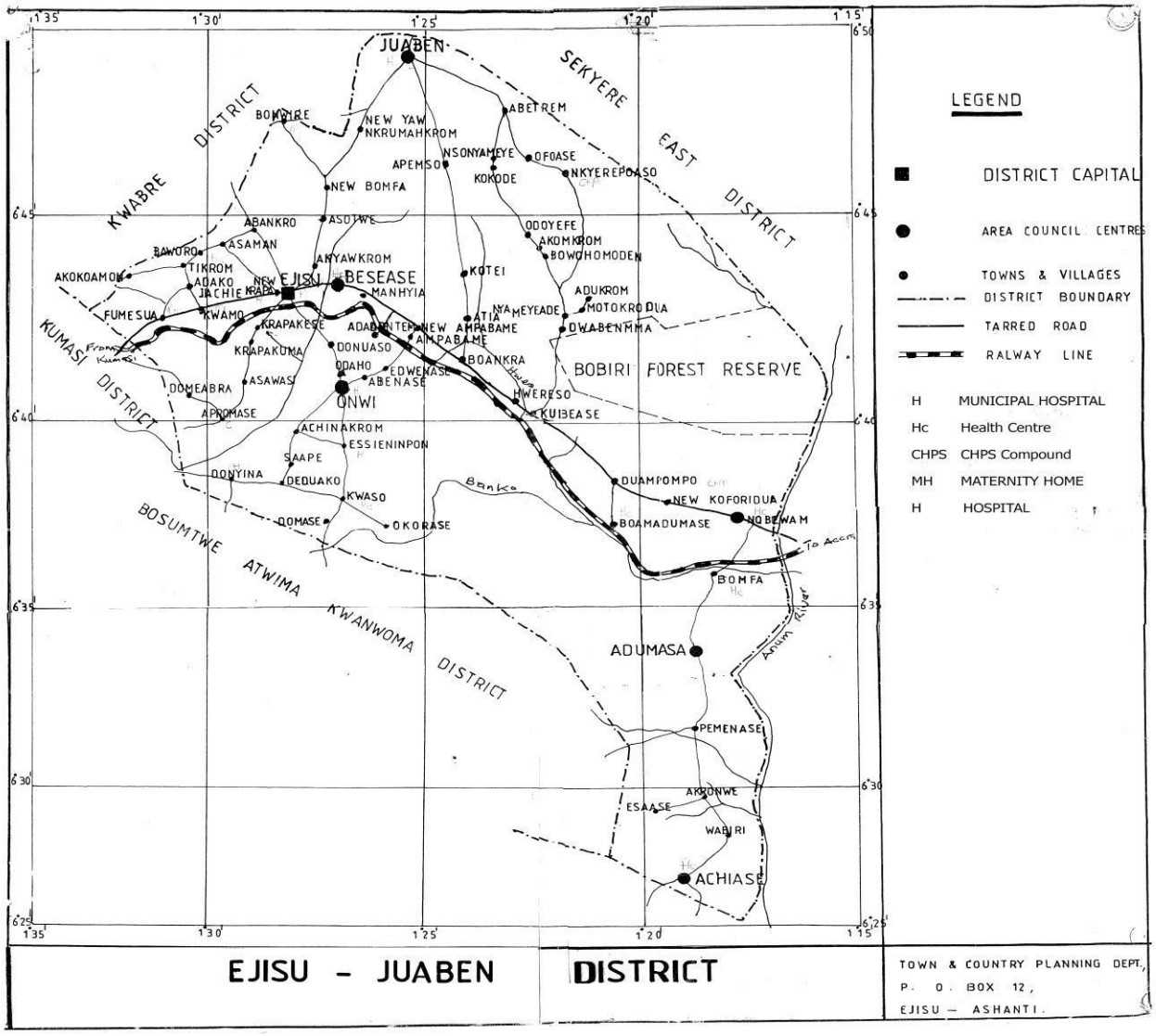

Figure 3.2: Base map of Ejisu-Juaben Municipality showing the study areas

3.3 Units of Analyses

The units of analyses were households and other institutions in *Ejisu*, *Fumesua* and *Kwamo* in the Ejisu-Juabeng Municipality. Household is one of major stakeholders in waste generation. The waste generated by households goes through several processes before final disposal. The generation and handling of waste by households is necessary for its efficient management. Institutions considered included Zoom Lion Company Limited and the District Assembly.

3.4 Data Collection

Data was gathered from different sources to get a complete understanding of the case. Data collection was grouped into three namely; primary, secondary, and interviews. The field work was started in November, 2012 and ended in January, 2013 lasting a period of three months. The focus of the study was to look at waste generation and disposal situation in each of the towns. As a baseline investigation, the waste quantification was carried out within 14 days in two months (December and January) thus, 7 days in each month. The exact dates for the first month study were repeated in the second month for each of the towns. Data was also collected from the Ejisu-Juabeng Municipal Assembly and Zoom Lion Company Limited who are directly involved in waste collection and disposal in the area.

3.4.1 Primary data collection – Survey Questionnaire

The primary data collection encompassed the use of structured questionnaire to obtain data from households, waste management company (zoolion Gh.Ltd) and the Municipal Assembly. This data provided information on the waste generation and disposal and the socio-economic background of respondents. Information such as age of respondents, educational levels, occupation of

respondents, waste separations, waste storage receptacles and methods of waste disposal was obtained. Samples of the questionnaire are provided under Appendix.

3.4.2 Secondary data collection

Secondary data was obtained from journals, books, articles, newsletters and other useful materials on the internet. The secondary data assisted in reviewing existing information on the issue.

3.4.3 Interviews

Interviews were conducted for households, staff of Zoom Lion Company Limited and staff of the sanitation unit of EJMA, respectively who consented to the study to gather data on waste management. In all, 10 people were interviewed, 4 from households, 3from zoom lion and 3fr the district assembly. Interviews were conducted in the local dialect for households (i.e. Twi) for ease of understanding and to provide the correct responses since some of them neither understood nor could speak the English language. On the average 25 minutes was spent on each respondent. Most of the responses for the interview came from women even though the focus was not on women. The men referred the personnel to the women with the reason that women are responsible for waste handling. However, few of the men agreed to be granted the interview.

This allowed for their views also on the issue. The field interviews started from about 9.00 am to 11:00 am and continued from 2:00 pm to 5:00 pm daily till completion in other not to disrupt respondents‟ daily activities.

3.5 Sampling Method

The sampling procedure for the study was deemed as being paramount in attaining the set objectives of the study. Household was chosen as the unit of analysis because of the cultural

practice and joint-family structure that exists where incomes are joined together for the purpose of any expenditure decision. Sample size (*S*) considered for the research was estimated using the formula (Israel, 1992);

$$S = N/(1 + N)e^2 \quad [3.1]$$

where *N* is the total number of households in the study areas and *e* is the error margin at 10% with confidence level of 90%. An estimated number of 100 households were sampled. The total household size from the three towns was 6938 partitioned by percentage as 59% for *Ejisu*, 23% for *Fumesua* and 18% for *Kwamo* based on the individual number of households in each town. Table 3.1 shows the summary of the stratified sample distribution for the three towns.

Table 3.2: Summary of stratified sample distribution for the towns.

Town	**Population**	**Households**	**Weight (%)**	**CL (90%)**
Ejisu	18,391	4,087	59	58
Fumesua	7,076	1,572	23	22
Kwamo	5,753	1,278	18	20
Total	**31,220**	**6,938**	**100**	**100**

3.5.1 Sampling technique

A multistage sampling technique was employed for the study. The first stage involved the use of purposive sampling techniques to select the towns for the research. The second stage involved stratifying the towns into zones based on suburbs in the towns because of limited information such

as income groups and also the homogenous nature of buildings within the study areas. Systematic sampling technique was then used for the third stage whereby every 5th building was sampled.

3.6 Solid Waste Characterization and Measurement

In the determination of the composition of waste by weight/day for every household, households selected were given polyethylene bags to keep their daily waste. The polyethylene bags were tagged according to the numbers of the households for easy identification. At each house, two large polyethylene bags were given to households selected, one for putrescible and the other for other forms of waste. The polyethylene bags were collected every morning and gathered at a point where they were emptied for segregation and measurement. This took about two hours daily for 14 days. Wastes obtained were sorted into different classes by hand protected with hand gloves, nose mask, overall garment and proper foot wear to identify the waste types and weighed separately using the a spring weighing scale to determine the quantities of various components. Digital camera was used to take photographs during the study. Figure 3.1 shows a photograph of the researcher taken during sorting of the waste. The total weight of the waste streams was then obtained by simple addition of all weights in the study areas. Average waste quantities and percentage was than calculated for each component identified. Average per capita waste generation per day was calculated by dividing the average total waste by the total households size multiplied by the study period (14 days). The per capita waste generation (*GPC*) in the towns was calculated using the equation.

$$GPC = WT/14H \quad [3.2]$$

where *WT* is total weight of waste (kg) and *H* is the population and 14 is the period for the study in days.

Figure 3.3: Waste sorting and measurement by the researcher.

3.7 Research Approach and Data Analysis

The research was carried out using qualitative and quantitative data gathered on the field and from households and other institutions visited and data utilized for analyses. Data collected was analyzed with Microsoft excel, Statistical Package for Social Scientists (SPSS version 16.0) and Statistix (version 9.0) and compared using single factor analysis of variance (ANOVA) at 95% confidence interval. The one–way ANOVA was employed to test for variations in waste generation in the three towns. Linear regression was used to establish the relationship between household size, income and waste quantities. The results obtained are presented in Chapter Four.

3.8 Challenges of the Research

The sampling could not be done co-currently and also for longer period due to limited resources and personnel to assist in conducting the research. Most interviewees were cold towards the administration of questionnaire to them because they felt sceptical about answering some of the questions even though it was explained to them as being for academic purposes only. Another challenge was that, most of the people felt their waste was being taken for ritual purposes and a lot of time was spent on explaining the need and getting them to understand.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

The results and discussion of the study are presented in this chapter. The results and discussion have been grouped into five namely: general characteristics of respondents, waste types and

composition, solid waste handling and disposal, personnel and equipment for waste management and incentives for sanitation workers.

4.2 General Characteristics of Respondents

In the three communities, 100% responses were received from females in *Ejisu* and *Kwamo*. Five percent (5%) of the respondents from *Fumesua* were males whiles 95% of the respondents were females. Thus waste handling is predominantly managed by females in the study areas. Similar trend has been reported by Afroz *et al.*, (2010) in their study in Dhaka City, Bangladesh. The reason is attributed to the menial task nature of waste handling which could be managed effectively by weaker members in the household especially, women and children. Thus, for improvement in sanitation behaviour, formal education for women in the society is of paramount importance since they are directly involved in handling waste in the households (Pacey, 1990).

Figure 4.1 shows the age distribution of the respondents in the three towns. In *Kwamo*, 35% of the respondents were aged between 26-32 years, 30% between 18-25 years, 27% between 33-36 years and 5% above 51 years. In *Ejisu*, the highest percentage (31%) of the respondents also fell between 26-32 years, followed by 21% between 44-50 years, 14% between 33-36 years, 13% above 51 years and 9% between 18-25 years. Like *Kwamo* and *Ejisu*, the highest percentage

(32%) of the respondents in *Fumesua* were aged between 26-32 years, followed by 27% between 33-36 years, 18% above 51 years, 9% between 44-50 years and 5% between 18-25 years. Thus, the average age of the respondents was about 35 years with the youngest being 18 years and the oldest > 51 years. The ages of respondents indicated that varied views were received on waste management‟s in the study areas.

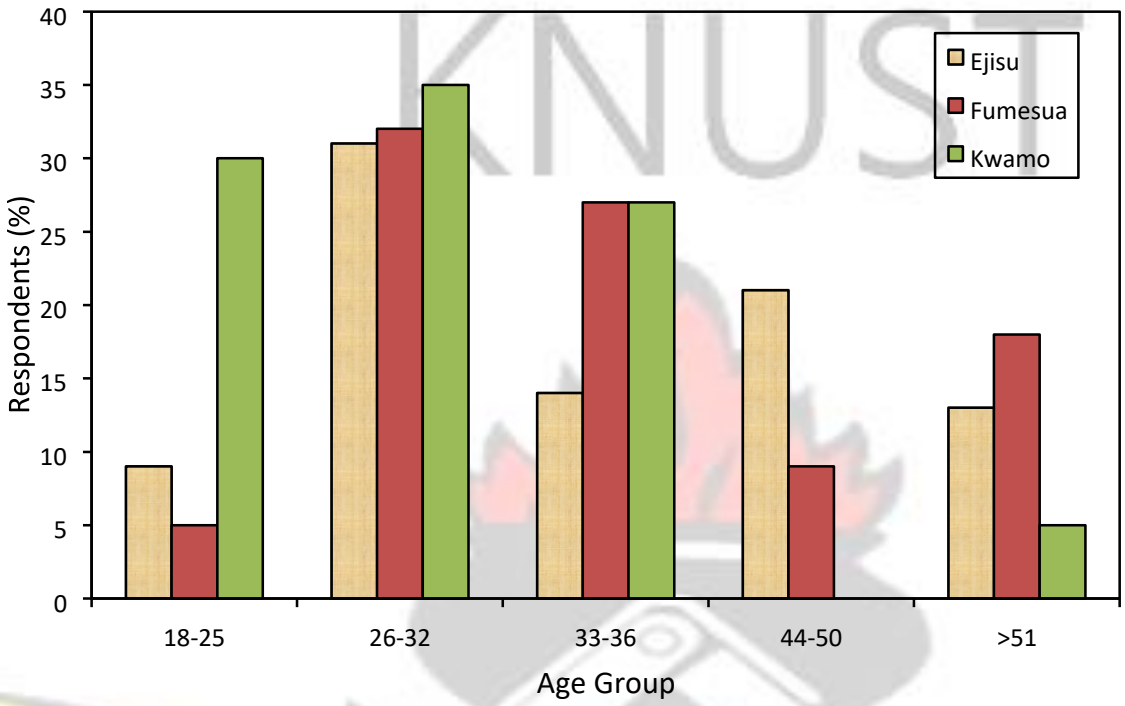

Figure 4.1: Age distribution of the respondents in *Ejisu*, *Fumesua* and *Kwamo*.

The educational levels of the respondents are shown in Figure 4.2. About 21%, 14% and 25% of respondents in *Ejisu*, *Fumesua* and *Kwamo*, respectively had no formal education. The rest of the respondents have had some form of education, either up to primary, secondary or tertiary level. Majority of the respondents had completed JHS/Middle school in all the three towns. The distribution of educational levels shows varied understanding of waste management issues by respondents. It is interesting to note that little or no education could indicate limited knowledge or understanding in waste management issues.

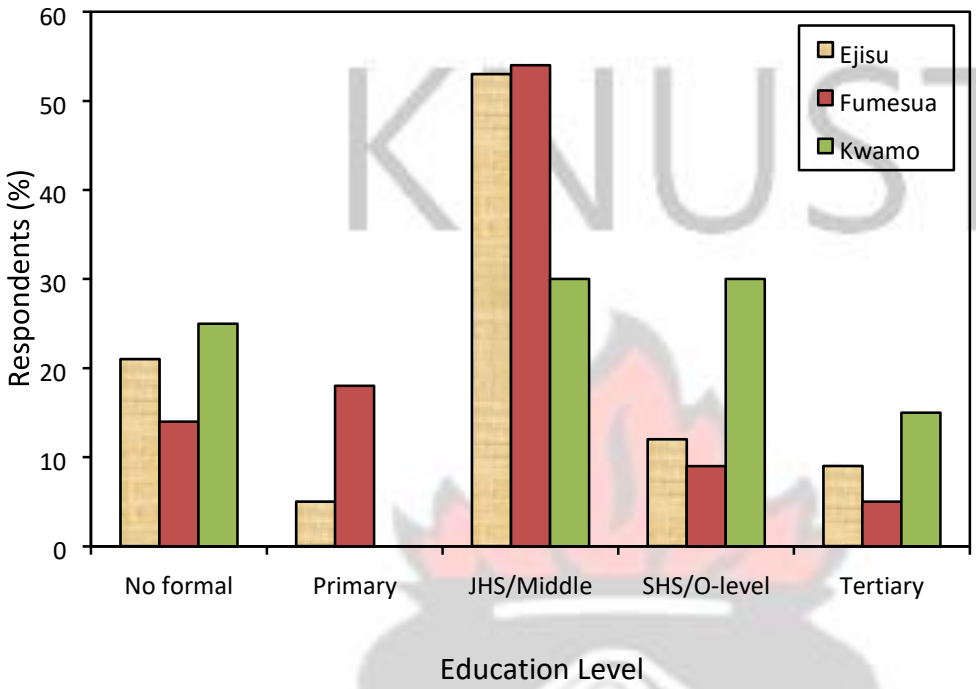

Figure 4.2: Educational level of respondents in *Ejisu, Fumesua* and *Kwamo*.

Figure 4.3 shows the various occupations of the respondents in the three towns. Government workers (salary workers) constituted 5%, 23% and 20% of the respondents in *Ejisu*, *Fumesua* and *Kwamo*, respectively. Majority of the respondents were traders with 70% in *Ejisu*, 60% in *Fumesua* and 65% in *Kwamo* whilst 3% and 14% of the respondents in *Ejisu* and *Fumesua* were engaged in farming activities. About 2% of respondents in *Ejisu* were unemployed and 20%, 3% and 5% in *Ejisu*, *Fumesua* and *Kwamo*, respectively were involved in other forms of occupation. The average income levels of the three towns were GH¢ 599.40, GH¢ 451.50 and GH¢ 474.00 for *Ejisu*, *Fumesua* and *Kwamo*, respectively. The occupational distributions give ideas on sources of income and could define the economic standings of respondents in each town.

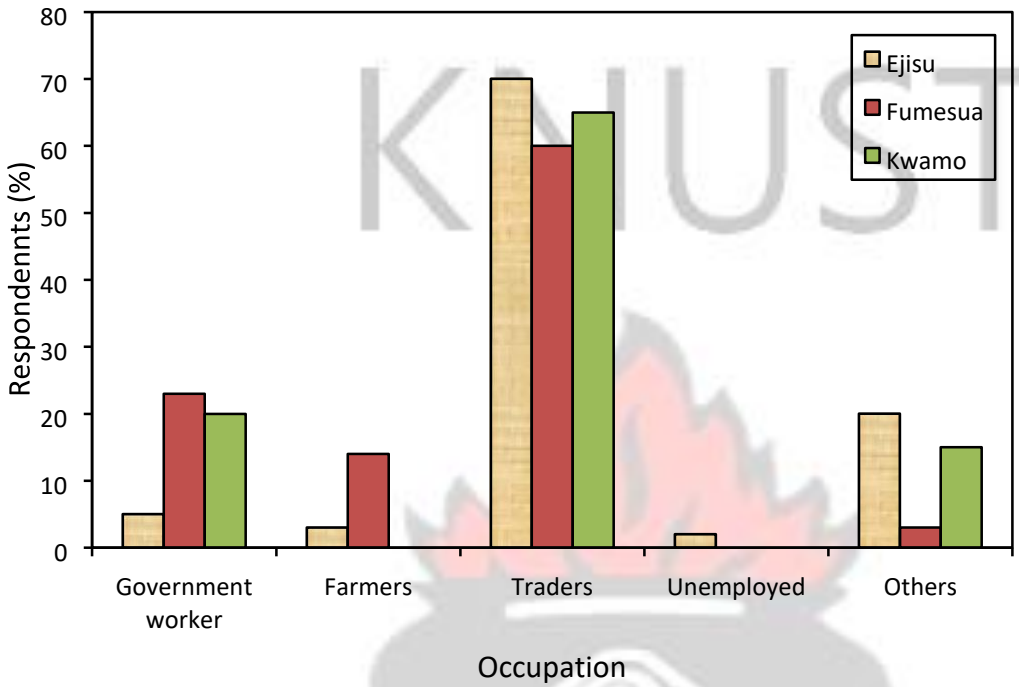

Figure 4.3: Occupation of the respondents in *Ejisu*, *Fumesua* and *Kwamo*.

Data on the number of people in the households were gathered and grouped into sizes and the results are shown in Figure 4.4. The highest percentage of household size was between 4-6 people in all the three towns with about 73% in *Fumesua*, 48% in *Ejisu* and 65% in *Kwamo*.

Household size made up of 10-12 people recorded the least percentage and was seen in *Ejisu*. This could be due to the presence of the *Zongo* community in *Ejisu* which was absent in *Kwamo* and *Fumesua*. *Zongo* communities have usually large household sizes. The average household size calculated for the towns were 5 for *Ejisu*, 4 for *Fumesua* and 5 for *Kwamo*.

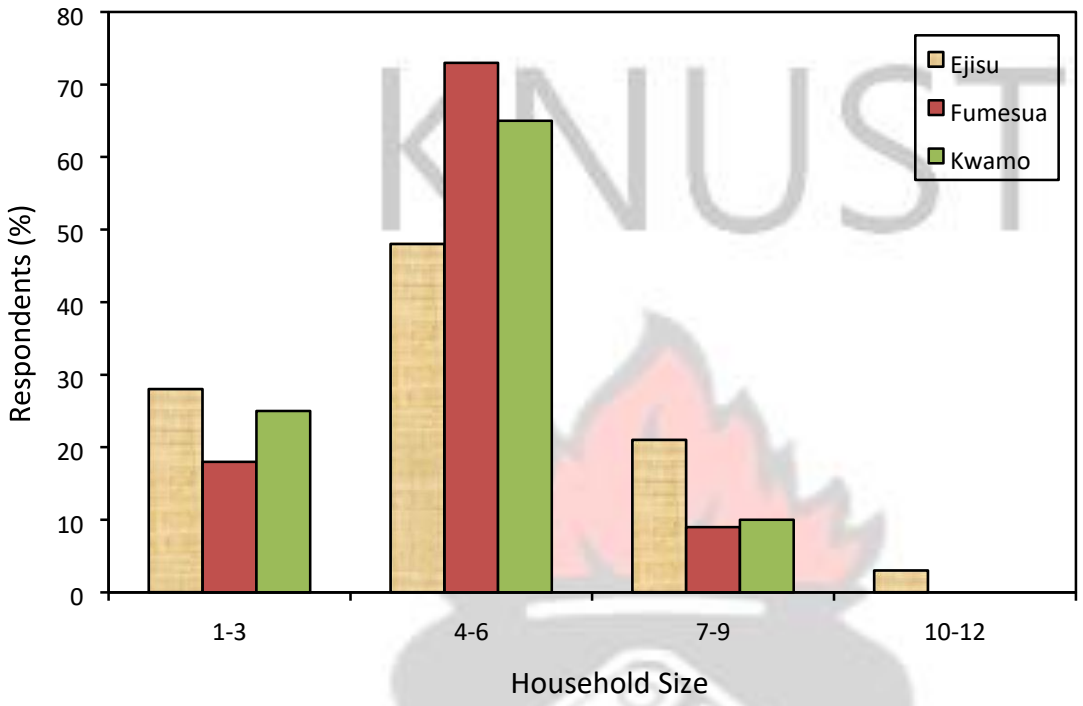

Figure 4.4: Household size of the respondents in *Ejisu*, *Fumesua* and *Kwamo*.

4.3 Waste Types and Composition

Figure 4.5 shows the variation in waste types and compositions in the three towns. The waste types identified in the waste streams were food waste, metals, paper, batteries, plastics, tins and cans, wood, textiles, fine residue, fruits, seeds and nuts and yard trimming. Among the different types of waste generated in the study areas, food waste recorded the highest percentages in all the three towns representing 40%, 46% and 38% in *Ejisu*, *Fumesua* and *Kwamo*, respectively. This was followed by fine residue (15%, 13% and 23% in *Ejisu*, *Fumesua* and *Kwamo*, respectively), plastics (14%, 10% and 13% in *Ejisu*, *Fumesua* and *Kwamo*, respectively), paper (8%, 3% and 10% in *Ejisu*, *Fumesua* and *Kwamo*, respectively) and wood (4%, 7% and 3% in

Ejisu, *Fumesua* and *Kwamo*, respectively). Batteries which may contain toxic chemical recorded least percentage in the solid waste stream in all the three towns constituting less than 1.2%. The waste types identified were similar to what has been reported by Fobil *et al*., (2005) in Accra and Mensah (2008) in *Atwima Nwabiagya*.

The composition of plastic waste is an important issue in the management of waste. This is because the types of plastic waste affects the technique in its disposal and is necessary for deciding on reuse, reduction and ultimately recycling of waste. The percent of plastic (10%) realised in the waste stream at *Fumesua* was the same as that reported by Mensah (2010) but that of *Ejisu* and *Kwamo* were higher (14% and 13% respectively). This high percentage of plastic may influence the cost of recycling of the waste in terms of separation.

Sustainable amount of waste types that could be termed recyclable waste (i.e. paper, glass, metals, plastics) were also identified. Among the waste types generated in the three towns 28%, 29% and 48% in *Ejisu*, *Fumesua* and *Kwamo*, respectively were recyclable waste. The quantity of recyclable materials in the study areas present opportunity for recycling ventures in the areas by investors and the district assembly. Recycling of the waste can also reduce the amount of waste that has to be transported to the disposal sites. It may also encourage waste sorting among residents if the waste is bought as raw materials. This could also improve the economic standings of household in the study areas. If the district assembly institute recycling activities, it could serve as a plough back venture that could be used to fund waste management and even other sectors.

The study revealed high percentages of organic waste in all the towns with *Fumesua* representing

69%, *Ejisu* 54% and *Kwamo* 49%. The findings were similar to what has been reported by Anomanyo (2004) in Accra and Mensah (2008) in *Atwima Nwabiagya*. The high percentage of organics in the study area implies that, the people depend mostly on organic foods and this could be as a result of the peri-urban nature of the areas (EJMA D. Plan, 2011-2013). The high putresible waste being generated in the study areas require prompt conveyance of waste containers to avoid the incidence of flies and stench from rotting of waste which could impact negatively on the environment (Waldron *et al*, 2004). The high organic waste produced in these areas can be composted to serve as manure to boost agriculture in the study areas.

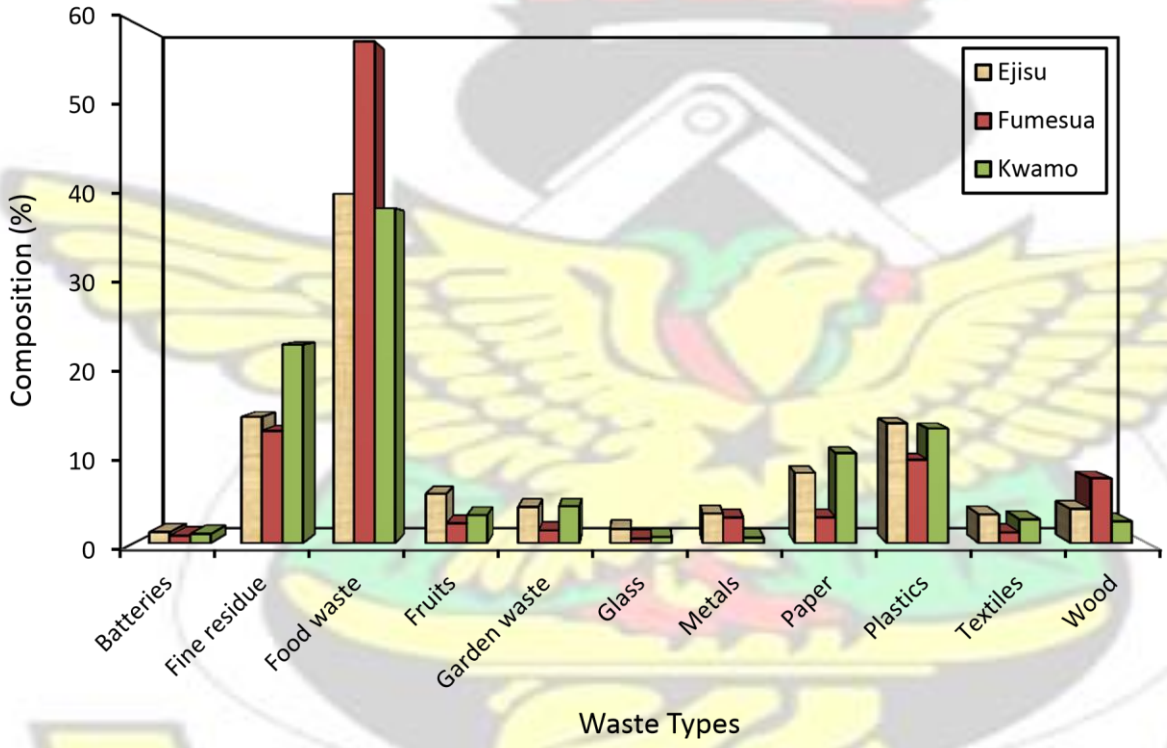

Figure 4.5: Waste compositions and variations in *Ejisu*, *Fumesua* and *Kwamo*.

4.4 Waste Generation Rates

Over the two (2) weeks study period, *Ejisu* recorded the highest mean quantity of solid waste of 814.6 kg (1629.2 m^3) followed by *Fumesua* (455.9 kg – 911.8 m^3) and *Kwamo* (252.7kg – 505.4 m^3), respectively. Solid waste generation rate were 58.20, 32.60 and 18.10 kg/day, whiles the per capita waste generation rates were 0.2, 0.3 and 0.2 kg/person/day in *Ejisu, Fumesua* and *Kwamo*, respectively. *Fumesua* had the highest per capita generation per person per day with *Kwamo* and *Ejisu* having the same per capita waste generate rates. The similarity of waste generation rate between *Ejisu* and *Kwamo* could be explained by the fact that, the towns are located within the same geographical area and therefore lifestyles of the inhabitants could be similar. On the other hand, *Fumesua* had high percentages of literates than *Ejisu* and *Kwamo* and this might have influenced their lifestyles and hence their waste generation rates. Additionally, *Fumesua* also had relatively high percentage of government workers and their economic backgrounds might have influenced their purchasing power and probably translated to the relatively high waste generation rates.

It was observed that the differences between the total waste quantities generated during the study period in the three towns were significant ($P < 0.00$). There were no significant differences observed in the per capita waste generation in *Ejisu* and *Kwamo* as compared to *Fumesua*. However, there were significant differences in the generation rates per households in all the towns. As mentioned earlier, the respondents in *Fumesua* have better socio-economic backgrounds which may have influenced their waste generation rates. This implies that residents in *Fumesua* might have adapted to convenient lifestyles that produced high amount of waste. On the other hand, residents from *Ejisu* and *Kwamo* had low per capita income or low stock rate per capita and produced relatively low amount of waste and hence have a low per capita waste generated per

person per day. The two towns are also close to each other and lifestyles in these towns may be similar hence relatively low waste generation rate. Thus the waste generation within the study areas could be explained by other socio-economic factors such as household size, education, cultural patterns and personal attitudes and income as identified by Al-Momani (1994). It is however interesting to note that the per capita waste generation in all the three towns were below 0.5 kg/person/day which are within what has been reported by Lardinoi *et al*., (1999) as the per capita waste generation rate for low income groups in Accra. This suggests that the people in the study areas may fall within the low income group. This was confirmed by the Municipal Assembly`s description of the study areas as low income areas (EJMA D-Plan, 2010 – 2013, Mensah, 2010).

The wastes generated per household per day were 1.0 kg, 1.48 kg and 0.9 kg for *Ejisu*, *Fumesua* and *Kwamo*, respectively. *Ejisu* and *Kwamo* had lower waste generation per household compared to *Fumesua*. It is envisaged that probably more of the people in *Ejisu* and *Kwamo* spent longer hours of the day outside their homes during the study period and therefore the waste they might have generated during those hours remained outside their homes. Also relatively high percentages of respondents had large household sizes in *Fumesua* which might have contributed to the relatively high waste generation rates per household.

The relationships between waste generation and some socio-economic factors were investigated. The regression analysis (Table 4.1) showed no significant relationship between education and waste generation rate in all the towns ($P > 0.05$). Waste quantity had a positive correlation with household size in *Ejisu*. Thus as the household size increased, waste quantity also increased. The strength of this relationship was estimated to be 26.6%. Similar finding was reported by Afrox *et*

al., 2010 in Dhaka, Bangladesh. However, there were no correlation between household size and waste quantities in *Fumesua* and *Kwamo*. As income increased, waste generation rate increased in *Kwamo,* but decreased in *Ejisu* and *Fumesua*. The inverse relationship between household size and waste generation in *Fumesua* and *Kwamo* has also been reported by other researchers in other study areas (Bolaane and Ali, 2004; Mensah, 2008; Omole and Alakinde, 2013).

Monthly income had negative correlation with waste generation in *Ejisu* and *Fumesua* but was positive in *Kwamo*. Both positive (Omole and Alakinde, 2013) and negative (Afrox *et al*., 2010) correlation between income and waste generation has been reported. Generally, the relationship between waste generation and socio-economic characteristics of respondents was not significant in all the three towns (P > 0.05) (Tables 4.1). A unit change in any of the socio-economic factors affects change in waste generation by 2.9% in *Ejisu,* 12.3% in *Fumesua* and 6.3% in *Kwamo* depending on the relationship that exist between the socio-economic factors and waste generation (i.e. whether negative or positive). Education negatively correlated with waste generation in all the towns. This finding agrees with what has been reported by Afrox *et al*., 2010 in Dhaka, Bangladesh but however contradicts report by Omole and Alakinde, (2013) in Ibadan in Nigeria. This indicates that, income and household size are the possible socio-economic factors that could probably influence waste generation in *Ejisu* whilst income is the only influencing factor affecting waste generation in *Kwamo*. Thus economic standing of people living in the study areas could possibly influence consumption patterns, thereby reflecting on their lifestyles and translating into waste generation.

Table 4.1: Correlation between waste quantity (dependent variable) and socio-economic factors.

Independents Variables	**Coefficient (r)**		
	Ejisu	Fumesua	Kwamo

Household size	0.266	-0.821	-0.029
Education	-0.513	-0.417	-0.417
Income	-0.002	-0.022	0.299
P	0.970	0.720	0.480
R^2	0.029	0.123	0.063

4.5 Solid Waste Handling and Disposal

Waste disposal in the study is managed by Zoom Lion Company Limited, a private waste management company in Ghana and the sanitation units of the District Assembly. These institutions are responsible for ensuring effective collections and final disposal of the waste in the study areas. The respondents were asked a number of questions on their perception on waste handling and disposal in their communities. The results are summarised as follows.

4.5.1 General perception of waste handling

The general perception about the work of the waste collection agency (i.e. Zoom Lion Company Limited) in *Ejisu* and *Kwamo* were good. However, in *Fumesua*, about 75% of the respondents believe that their work is not efficient and are willing to help manage the waste generated in the area effectively. Among the suggestions provided to manage the waste in their locality include clean up exercise, provision of adequate refuse containers, and regular conveyance of waste containers. Covering of skips and inspection by sanitary inspectors were also of concern to the people. Table 4.2 summarises the suggestions made by the respondents on proper waste management.

Table 4.2: Respondents suggestions on effective waste management options.

Suggestions	Respondents (%)
Provision of Enough skips	24
Clean-up exercises	35
Regular conveyance of skips	12
Covering of skips	5
Effective inspection	5
Public education	4
Funding of waste management	3
Prosecution of offenders	3
Expansion of work by Zoom Lion	3
Implementation of waste sorting at source	2
Incentives to waste management staff	2
Waste billing per household	2

About 65% of the respondents from *Kwamo*, 64% from *Ejisu* and 41% from *Fumesua* educate their households on the need to keep their surrounding clean. Other respondents also keep their surroundings clean for improved personal hygiene (i.e. 12% in *Ejisu*, 25% in *Kwamo*, and 59% in *Fumesua*) whilst others have different reasons for keeping the surrounding clean including disease prevention, avoid prosecution and ethical requirements. Figure 4.7 summarises the various reasons provided for keeping their surroundings clean

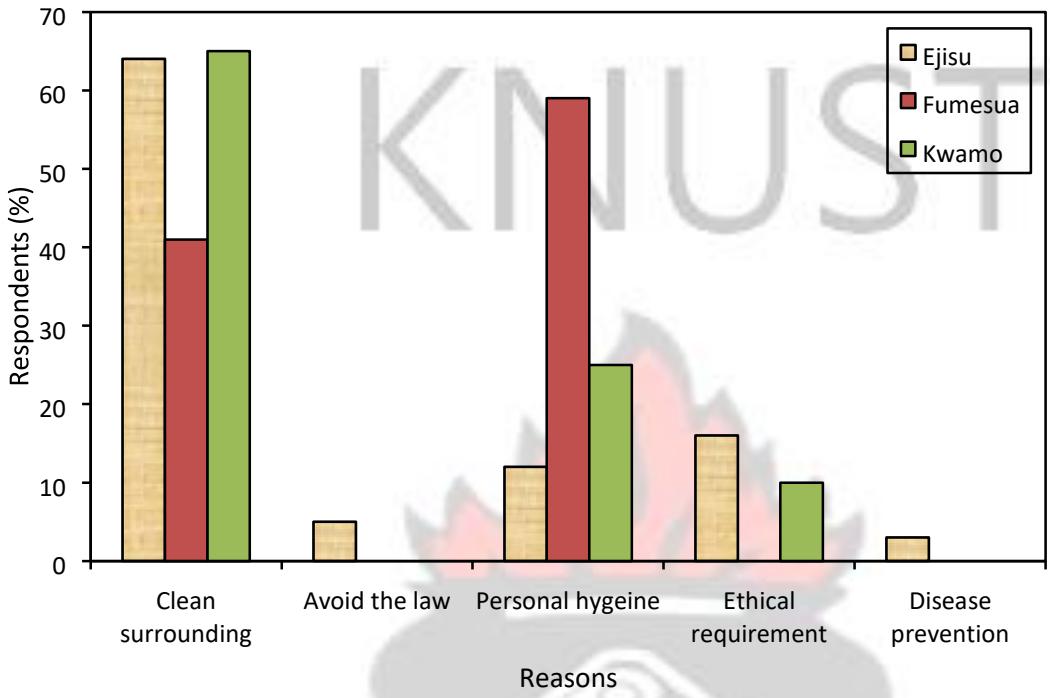

Figure 4.6: Various reasons for cleaning surroundings in *Ejisu*, *Fumesua* and *Kwamo*.

4.5.2 Waste sorting

It was also found out that 69%, 86% and 70% of the respondents in *Ejisu*, *Fumesua* and *Kwamo* had no knowledge on recycling waste generated in the community. Additionally, all the respondents interviewed at *Fumesua* and *Kwamo* did not sort their waste before disposal whilst only 13% in *Ejisu* sort their waste occasionally for harmful materials that could harm children who are sent on waste disposal errands. Thus waste sorting is not practiced among residents in the study areas. Similar observation was made in Tamale Metropolis in Ghana where about 74% of the people do not sort their waste before disposal (Abagale *et al*., 2012). Waste sorting is not common practice because the systems of waste collections are not designed to include source separation of

waste and therefore adequate facilities are not provided to households to source separate their waste.

4.5.3 Waste storage receptacles

Solid wastes generated within the communities were stored in different containers including baskets, plastic/metal waste bins, polythene bags, wooden boxes among others. Plastic/metal bins were the most widely used waste receptacle in *Ejisu* constituting about 59% of respondents. Polythene bags were mostly used in *Kwamo* (50%) whilst dustbins were mostly used in *Fumesua* (53%). The variations in waste receptacles used in the towns are summarised in Figure 4.8. The receptacles used for waste storage in the study areas were similar to what has been reported by Freduah, (2004) in *Nima*, a suburb in Accra. With the exception of the dustbins, none of the waste storage containers used by the people had covers**.** A considerable amount of the rubbish was also put into polythene bags before kept in the storage containers; an observation similar to what has been reported by Boadi and Kuitunem (2005) in Accra. These waste handling methods is one of the possible factors for indiscriminate disposal practises in the study areas, because much of the refuse fly out of the storage containers before reaching the sanitary points/sites.

Generally, it was realised that a greater percentage of the respondents relied on plastic/metal bins than other storage methods. This might be because it is cheaper, available, and perhaps could store more waste. However, lack of covers and placement of bins close to kitchens and corridors in the house have serious health implication. The EJMA could provide standard dustbins at subsidized prices to inhabitants and offer education to residents on the need to store refuse in dustbins with covers in order to avert any health risk that may arise due to poor waste handling in the study areas.

The more the households get educated and are aware of the side effects of unmanaged solid waste, the better they are likely to make the best choices in managing waste.

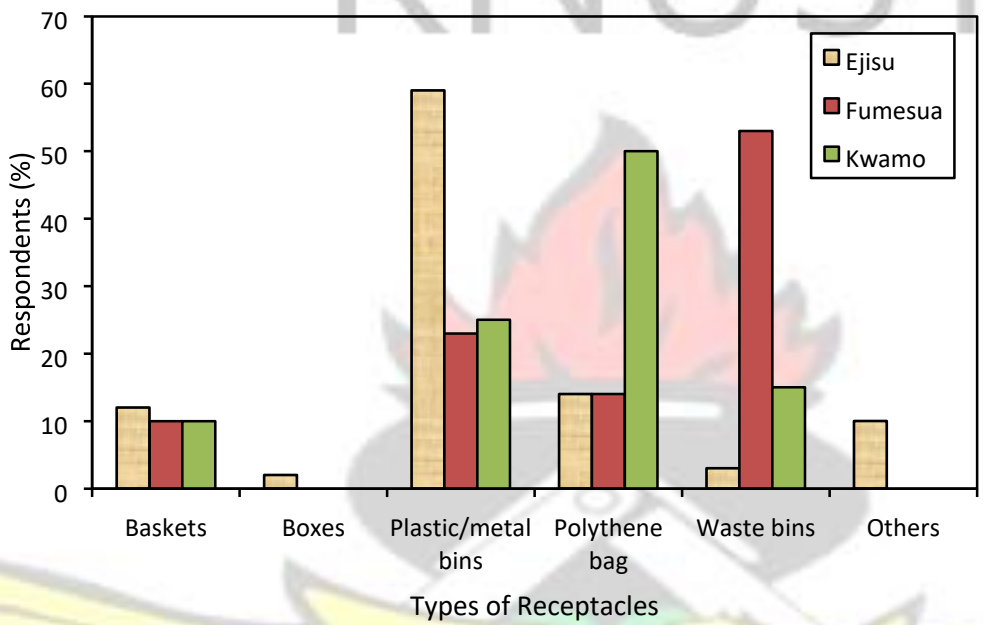

Figure 4.7: Types of receptacles for waste storage in *Ejisu*, *Fumesua* and *Kwamo*.

4.5.4 Waste disposal methods

All the respondents in *Kwamo* used the communal containers as their mode of refuse disposal. In *Ejisu*, 98% of respondents depended on the communal containers as their means of disposal while 2% practiced open dump method of waste disposal. An example of the communal containers is shown in Figure 4.8. About 77% of respondents in *Fumesua* practiced open dump disposal of solid waste whilst 5% dump in bushes and 18% depended on communal containers as means of disposal. This finding was different from what was observed by Benneh *et al.* (1993) in Accra where they argued that because the capacity to handle all of the household waste generated was weak, about 83% of the population dump refuse in either authorized (open dump site) or unauthorized sites in

their neighbourhood. The less dependency of the people of *Fumesua* on communal containers is as a result of a huge refuse dumpsite located within the town (Figure 4.9). It was observed from the survey that people relied heavily on EJBM facilities for their refuse disposal. None of the respondents depended on private waste collectors (contractors). The situation as presented above partly explains why the EJMA is unable to cope with waste disposal of solid waste in the study area. As majority of household depend on EJMA for their solid waste disposal, it puts pressure on the equipment and insufficient work force, among other things. It is therefore essential for the municipality to solicit for funds or restructure the solid waste management system and to provide more waste bins to cater for the situation.

Figure 4.8: Skip for receiving refuse from households and commercial centres.

Figure 4.9: Open dumpsite located in *Fumesua*.

4.5.5 Waste disposal time

Solid wastes generated were disposed of at the communal waste containers (skips) at different times during the day. The disposal times varied from households to households and from one town to the other. Figure 4.10 shows the different waste disposal times for the three towns. It was realised that most of the respondents disposed their waste in the morning. Majority of respondents disposed their waste between the hours of 6:00 am and 7:00 in all the three towns. Only 2% of respondents from *Ejisu* disposed their waste in the evening while 1% disposed their waste at any time during the day. Traditionally, house cleaning is carried out in the morning and just after that, waste has to be transferred to the disposal site or point. This could explain the trend of waste disposal in the study areas.

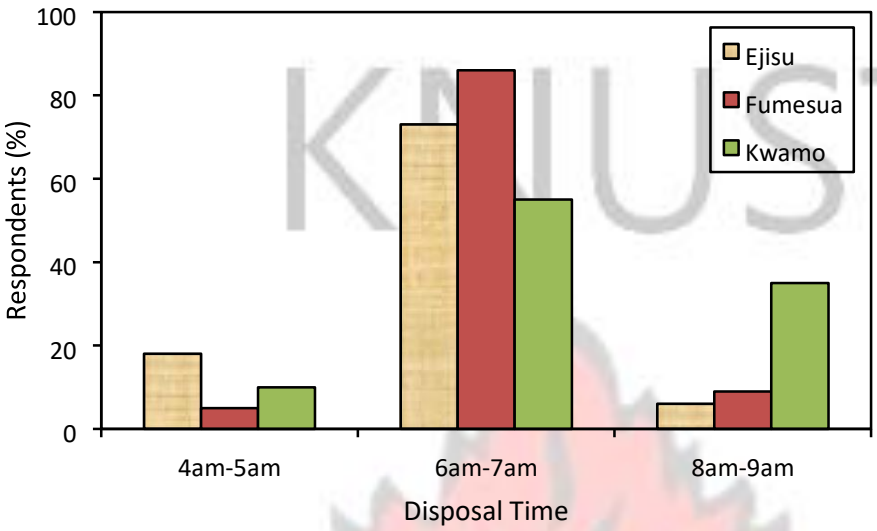

Figure 4.10: Time of disposal of refuse in *Ejisu*, *Fumesua* and *Kwamo*.

4.5.6 Persons responsible for waste disposal

Majority of the wastes were disposed of by children with *Fumesua* recording the highest percentage (64%) followed by *Kwamo* (58%) and *Ejisu* (50%), respectively. It is however believed that waste disposal is the responsibility of children. Some however, expressed concerns about the risk involved in sending children to disposal sites. About 57%, 38% and 14% of respondents from *Ejisu*, *Fumesua* and *Kwamo*, respectively would not ask their children to go to the disposal sites for fear of being knocked down by a vehicle whilst 38%, 29% and 21% of respondents from *Ejisu*, *Fumesua* and *Kwamo*, respectively tried to avoid indiscriminate disposal. Additionally, 21%, 24% and 33% of respondents from *Ejisu*, *Fumesua* and *Kwamo*, respectively would exempt their children from the activity to enable them prepare adequately for school. It must be mentioned here that all the children involved in waste disposal are school children between the ages of five to fifteen years. Such children were often asked by their parents and other family members to carry refuse to the sanitary sites/points. Similar observation was made by Hamdu (2009) in Kumasi.

Engaging children in waste disposal activities could be seen as instilling a sense of responsibility in them but the dangers and its health implication cannot be undermined (WHO, 1988). In comparison to adults, children lack the sense of judgment, experience and knowledge and may leave refuse at unapproved areas to reduce their burden of work.

Intensive education should be mounted for women in the study areas on the need to avoid using children in disposal activities or if they do so, supervise them to eradicate indiscriminate disposal. Also since the inhabitants believe involving children in the activity is a way of instilling a sense of responsibility in them, it then becomes necessary to involve them during waste management education.

4.5.7 Waste disposal charges

Majority of the respondents (>50%) in all the three towns believed the amount paid for disposal of waste was enough and should not be altered (see Figure 4.11). About 16%, 18% and 10% of respondents from *Ejisu*, *Fumesua* and *Kwamo* believed that the charges were high and therefore should be reduced whilst 2% and 5% of respondents from *Ejisu* and *Kwamo* also indicated that the amount collected for waste disposal (GHp 10 and GHp 20 per head) was too low and should be increased. Majority of respondents interviewed, however, indicated their displeasure on the way and manner the attendants at the disposal sites charge per head. The charges were based on attendant‟s weight judgement and not properly weighed using a weighing balance. This had resulted in several confrontations at disposal sites. If waste is not to be quantified for payment as many of the respondents objected to in the study areas, then the payment should be on standardized to avoid conflicts.

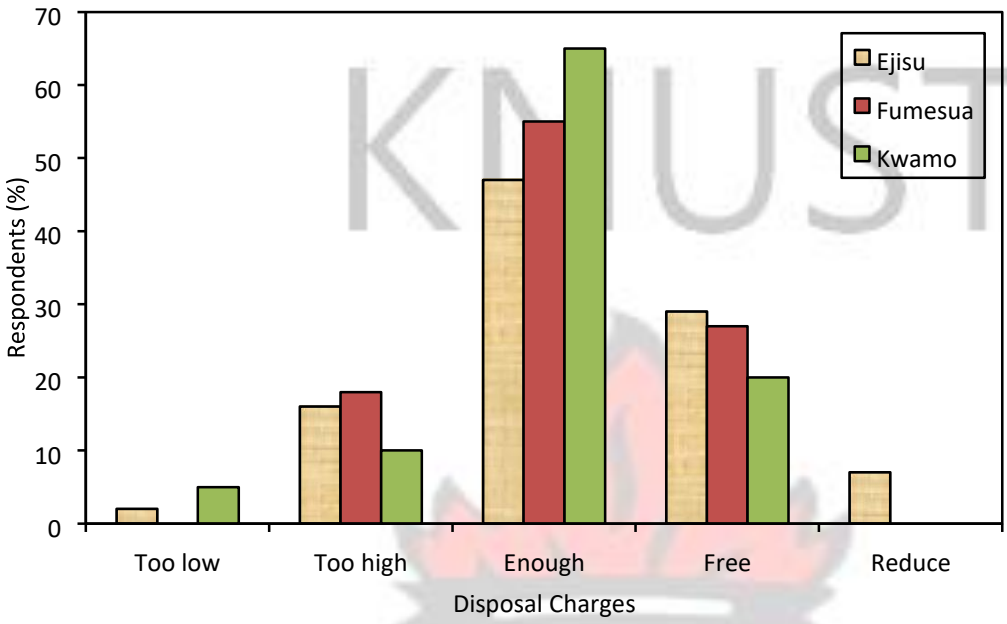

Figure 4.11: Views on the amount paid for disposal of refuse in *Ejisu*, *Fumesua* and *Kwamo*.

4.5.8 Location of skips

About 60%, 73% and 53% of the respondents in *Ejisu*, *Fumesua* and *Kwamo*, respectively believed the location of the communal waste containers (skips) were far from their households. They would rather prefer the skips positioned at a distance of 100m from their house. The preferred distances from respondents house to the skips were estimated using the 1m rule. The finding was in agreement with an observation made by Edmunson (1981) on refuse management in Kumasi. In his report it was pointed out that, most refuse dump sites were chosen without taking into consideration the distance to be covered by residents and recommended that sanitary sites should be cited close to waste generators. Adelaide (1995) also observed in Accra that, waste disposal sites are situated fairly a distance from inhabitants or sellers which could be a reason for disposing waste indiscriminately as observed in the study area (Figure 4.12). It would be appropriate to

implement waste collection systems that would be close to the people but environmentally friendly. Provision of information and education to the people on the need to position the containers where they are situated now could help remedy the situation.

Figure 4.12: Indiscriminate dumping of refuse in a drain at *Ejisu*.

4.5.9 Frequency of conveying skips and skips sufficiency

Responses obtained from respondents indicated that, skips positioned in the study areas were mostly lifted only when they were full to the brim and most at times overflows (Figure 4.13). Since most of the residents dispose their wastes of in the mornings, it would be appropriate to lift the filled skips in the evening so that by morning, the skips would have been emptied to avoid the situation of waste overflows at the disposal sites since it take an hour for the drivers to off load the skips at the dumpsite which is 11km from the study areas.

Figure 4.13: Skip filled to the brim at *Ejisu*.

Respondents shared their views on adequacy of skips in the study areas. All respondents in *Kwamo*, 95% in *Fumesua* and 93% of respondents in *Ejisu* established that the skips were inadequate. Similar observations have been made by Edmunson (1981) and Asamoah (1998) about inadequacy of skips in other cities that have resulted in indiscriminate disposing of waste. It is important for the people to be provided with adequate sanitary facilities to promote good sanitation in the study areas. This could assist Municipal Assembly to enforce sanitation bylaws to punish offenders since residents are aware of sanitation offences that could warrant prosecution. .

4.5.10 Door-to-door waste collection services

Regarding door-to-door waste collection services, 82% from *Ejisu*, 57% from *Fumesua* and 70% from *Kwamo* were in support of this service. When asked whether the communities would like to

engage the services of private waste collection agencies, about 65% of respondents from *Ejisu*, 62% from *Fumesua* and 50% from *Kwamo* showed interest to engage waste collection agencies. More than 80% of those in support think this could save them some time to attend to other business. The rest would engage their services because they are experts in waste collection and therefore there would be some consistency in the waste collection. The waste collection should however be done in the mornings.

On the other hand, several reasons were given for those who were not interested to engage the services of waste collection agencies and this include inability to pay for their services (~78% from *Fumesua*, 43% from *Kwamo* and 14% from *Ejisu*) and unreliability of the waste collection agencies (~43% from *Kwamo* and 29% from *Ejisu*). Majority of the respondents (~75% from *Kwamo*, 55% from *Fumesua* and 52% from *Ejisu*) were of the view that waste disposal should not be charge based on the quantity of waste.

4.5.11 Payment for door-to-door waste collection services

When asked how much the residents were willing to pay for the door-to-door service, majority of the respondents in *Fumesua* (68%) and *Ejisu* (31%) were willing to pay GHp 20 per head whilst in *Kwamo* majority (50%) were willing to pay GHp 10 per head. They were of the view that waste should be collected daily instead of the weekly collection. Figure 4.14 summarises the amount the respondents would like to pay for the door-to-door services. Generally, residents preferred daily payments to monthly payments. This is due to the fact that many of the people in the study areas had daily income and therefore would not be in the position to save for monthly payments for waste disposal. Also because the study areas were peri-urban in nature an appreciable number of

the inhabitants were still keeping to rural life style and see payment for waste disposal as an unnecessary burden brought about by civilization.

Although, all the respondents have high preference for the door-to-door waste collection service, the amount they prefer to pay for the services (i.e. GHp 20 per head load) seems inadequate in terms of labour involvement and cost of transportation. However the municipality can employ the use of tricycles and motor cycles in the collection of refuse from homes to hauling point for transportation. This would help minimize cost of labour and transportation and ensure better containment of waste in the study areas and promote better financing and management of waste. Educating inhabitants on the need to pay for waste disposal and the implementation of daily payment for door-to-door waste collection service would be more appropriate for the study areas.

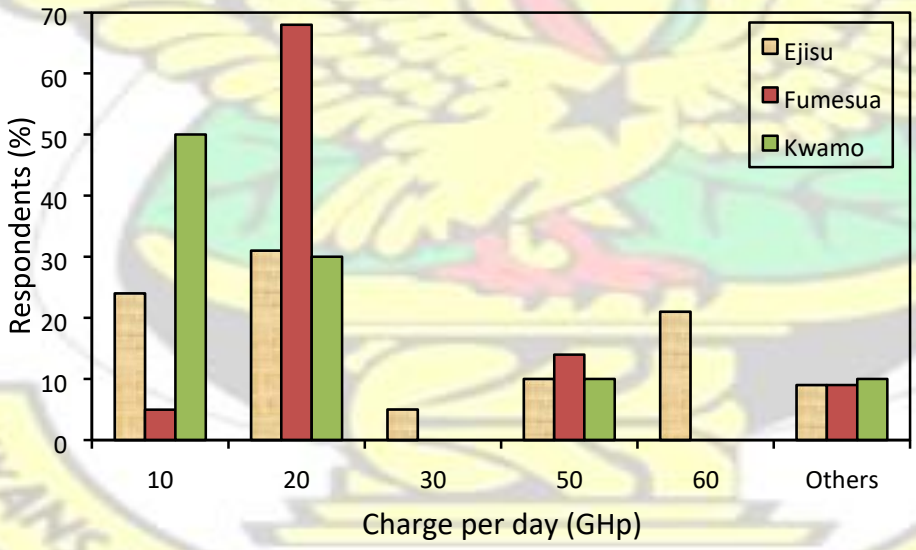

Figure 4.14: Preferred daily payment for door-to-door refuse collection in *Ejisu*, *Fumesua* and *Kwamo*.

4.6 Personnel and Equipment for Waste Management in Ejisu-Juaben Municipal Assembly (EJMA)

Waste management in the study areas was challenged by inadequacy of logistics and personnel to effectively handle the situation. Most of the equipment used was far below the optimum number requiring for the job. Limited number of trained staff coupled with lack of incentives for staff motivation was also a challenge in management. Tables 4.3 and 4.4 provide information on logistics and staffing in waste management in the study areas.

Table 4.3: Equipment types for solid waste management in EJMA.

Description	Number available	Optimum number
Skip loaders	2	4
Roll on trucks	2	2
Tricycles	46	60
Refuse vehicles	4	6
Refuse containers	36	60
Sanitary sites	2	3
Shovel	41	70
Rakes	22	30
Pick axes	6	10
Brushes	21	40
Wallington boots	21	30
Hand gloves	160	200
Wheel barrows	15	22

(Source: Zoom Lion Gh. Ltd, EJMA, 2010)

Table 4.4: Labour Strength of the sanitation unit in EJMA.

Labour Description	Number available	Optimum number
Sweepers (Women)	184	200
Cleaning Officers	1	3
Clearing guards	15	20
Sanitary inspectors	17	20

(Source: Zoom Lion Gh. Ltd, EJMA, 2010)

The EJMA has difficulty in coping with the solid waste management in the studied areas as the amount of waste produced far outweighs its capacity to dispose of due to inadequate skip loaders and waste bins (EJMA Health Officer, 2012). Equipments for waste transportation such as tricycles and skip loaders were also inadequate. For instance, tricycles are very much needed by the waste management institutions should they implement the door-to-door waste collection service. The use of tricycles could help beat down cost. Only forty-six (46) tricycles were available instead of the required number of sixty (60). Furthermore, the compaction trucks which could be used for the door-to-door collection were absent in the Municipality.

The inadequate equipment is as a result of limited funds and limited modern equipment and trained personnel. These problems coupled with the attitudinal and perceptual problems even exacerbate the problem. An interview conducted with waste management experts in EJMA indicated that, there were two sanitary sites serving the municipality.

The biggest problem facing the sanitation unit has to do with dictatorship from high ranking authorities and partial involvement of the sanitation unit in waste management in the studied areas. Majority of respondents complained of inefficiencies on the part of waste management personnel in handling sanitation issues in the study areas. The inadequate support by government to the EJMA and the delay in the disbursement of subvention has resulted, in the Department‟s inability to afford enough and better equipment to deal with solid waste.

The numbers of workers on the field at the sanitation unit in EJMA were known to be practically inadequate and non-professionals on the job coming from the Youth Employment Programme. More professionals, therefore needs to be employed into the sanitation department to handle waste management issues professionally.

The inability of EJMA to provide enough vehicles, skips, and personnel, is the reason for overflows of skips in the study areas where most at times inhabitants have to leave their waste bins and wait for the return of a skip loader before they can off load their waste. This confirms the reasoning that, the process of waste management is usually framed in terms of generation, storage, treatment, and disposal, with transportation inserted between stages as required (Gourlay, 1992). This problem has encouraged the use of various inappropriate methods of waste disposal such as open dumps and burning of the waste.

The help of concerned citizens, governmental organizations, and nongovernmental organizations in terms of the provision of funds and equipment may be a solution to this problem. Information

from EJMA indicates that, there is some levelling of waste at the dump sites but spraying to check the increase of flies and stanched or compaction of waste is not done. Fire outbreak is also frequent in the dumpsite due to lack of management.

There were no waste bins positioned along streets and on vantage points in the towns to receive refuse from pedestrians and other populace. The sanitation unit has been receiving complains on the frequency of conveying the skips but lack of funds has made it impossible to purchase more skips for the town. There are also no educational programmes on solid waste management for the people in that, the assembly`s budget does not cover education (EJMA Health Officer, 2012).

4.7 Incentives for Sanitation Workers

Tam and Tam (2008) revealed that, reward schemes and incentive systems contribute to employee awareness and motivation regarding waste reduction, and reduces waste by twentythree percent (23%). This is the reflection of the result obtained from the survey, which indicates inefficiencies in waste management. With such a problem at hand, sanitation workers did not work to their full capacity. This partly may explain why certain areas are littered in the towns. The analysis revealed that, majority of the residents would get involved in every aspect of the solid waste management in the study areas if given the opportunity. The survey report revealed that the people are willing to contribute financially and/or manually in improving solid sanitation in the towns. It is therefore the responsibility of the municipal assembly to institute activities that would directly involve the inhabitants. The delay in payment of salary to waste management personnel coupled with inadequate allowances and equipments in the study areas suggest that there are virtually no incentives that encourage workers in the study areas. Prompt payment of salaries and allowances

and provision of better equipments may provide incentives to waste management personnel‟s in the study areas.

CHAPTER FIVE

GENERAL DISCUSSION

5.1 Introduction

This chapter presents the key findings of the research. The findings have been grouped under five sections namely, waste collection and disposal methods, disposal of waste, resources and facilities for waste management and waste disposal charges.

5.2 Waste Collection and Disposal Methods

Inadequate skip supply was a major factor affecting waste disposal in the study areas especially, *Kwamo* where the residents depend heavily on the skips for disposal of their refuse. The survey established that majority of respondents lived at places further away from the skips and therefore have difficulties in disposing their waste into the skips. This had the tendency of residents to resort to indiscriminate dumping of waste into nearby gutters, backyards, opened spaces and other unapproved areas. Additionally, the skip ratio to population was very high. One skip serves about

3,065 residents in *Ejisu*, 3,538 in *Fumesua* and 5,753 in *Kwamo*. This goes to reaffirm the inadequacy of skip supply in the study areas.

Also, the issue of leaving waste containers at waste communal centre to empty into skips at later time because the skip has been transported to a landfill site is a disincentive to residents. This increases time spent by residents to dispose of waste at the few existing skips and even deny them of their waste containers for a period of time. This is a possible contributing factor for indiscriminate dumping of solid waste.

Personal communication with the skip attendants indicates that skip loaders had to be bribed before conveying the filled skips to the landfill site at regular interval. The waste management institutions in the study areas need to institute well structure system of skips/roll- on conveyance and adequate supervision of the movement of the waste vehicles. Certainly, there was irregular routine collection of waste by Zoom Lion Ghana Ltd in almost all the study areas. Waste collection was mostly carried out only when skips were full to the brim and at times overflowing before they were conveyed. In effect, the situation had resulted in people dumping their waste in opened spaces and in most cases burning as an alternative to disposal at the skips. Unlike the door-to-door collection which could possibly attracted a monthly charge of GH¢6.00 per household, if instituted in the study areas thus, GHp 20 per day, the communal collection was carried out at GHp10 and GHp20 per head load as determined by the attendants at the skips in the study areas. Although, residents in these areas were not requested to pay for waste collection daily on individual basis the institution of the door-to-door system could be feasibly from the research findings and therefore they Municipal Assembly could charge per house as being done in KMA.

5.3 Final Disposal of Solid Wastes

The study areas were served by two dumpsites which could be described as an open dump. The dumpsites were not engineered and there were no proper management protocol for the sites. Waste in the study areas is not sent to the KMA engineered landfill site due to cost. The sites were characterized by frequent smoke emanating from fire outbreak; there was also an incidence of flies and dust. There was no management of leachate from the site, the waste are only levelled but not compacted. The compacted sites are used for farming by residents. An example of the Donyina dumpsite which services the study areas and used for farming activities is shown in Figure 5.1. The sites could be possible sources of heavy metal pollution and could result in contaminating the produce from the land, a threat to human health. Additionally, waste was not usually separated into their various components before final disposal. This led to burying of some valuable resources in the dumpsites which otherwise could been re-used.

Figure 5.1: Maize farmed on graded portions of the *Donyina* dumpsite.

5.4 Resources and Facilities for Waste Management

According to waste management institutions (Zoom Lion and District Assembly), they are unable to deliver efficient services due to limited resources. Skips for storing waste generated were woefully inadequate as reported by the people in the survey. Thirty–six (36) skips were supplied for the whole Municipality. However, about 24 extra skips were required for efficient solid waste management in the study area.

5.5 Waste Disposal Charges

Although residents in the study areas seems to be content with the current payment plan, the issue of what quantity of waste should warrant either the GHp 10 or GHp 20 payment is a source of worry to the people. This controversy at times results in confrontations with skip attendants who are responsible for collecting the money and keeping the surroundings of skips clean. Waste quantification before payment would have to be addressed.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The study was conducted to quantify waste generated in *Ejisu*, *Fumesua* and *Kwamo* in the Ejisu-Juabeng Municipality and to assess the management of solid waste at both the household and District Assembly level. A survey was conducted to sample hundred households to assess their waste management practices and also for the waste quantification. These towns were purposefully selected based on the premise of population increase, histolic background and commercial activities.

The study revealed high levels of organic waste generated in all the three towns. There was no significant variation in waste quantities between the towns. The per capita waste generation in *Ejisu* and *Kwamo* was 0.2 kg/capita/day and that of *Fumesua* was 0.3 kg/capita/day which were below the national average per capita waste generation values of 0.5 kg/capita/day. Majority of residents in the study areas did not consider waste as a useful resource and therefore did not practice waste sorting before disposal. On the payment for waste disposal, majority of respondents in *Ejisu* and *Fumesua* opted to pay GHp 20 whiles residents in *Kwamo* opted to pay GHp 10 per load for door-to-door waste collection service.

High percentage of respondents in *Ejisu* and *Kwamo* depended on the communal containers which according to respondents were woefully inadequate whiles majority of the respondents in *Fumesua* practiced open dump system of waste disposal. The correlation analysis revealed nominal relationship between socio-economic factors such as household size, income and education on waste generation and as such could not be a good measure for waste generation in the studied areas. The study has demonstrated that, information on improper solid waste and disposal services in the studied areas were inadequate as shown by the way household handled and disposed of solid waste.

Therefore, all the objectives set were achieved and with regard to the main objective of the study it can be concluded that the following are indeed the key factors affecting effective waste management in the study areas. These include inadequate skip supply for storing waste; high population to skip ratio; lack of routine collection of waste, poor methods of waste management and inadequate resources for waste management institutions to effectively collect the waste generated.

6.2 Recommendations

Based on the findings of the study, the following are recommended for efficient and effective management of solid waste in the study areas.

1. **Provision of adequate dustbins and skips.** Adequate dustbins and skips should be supplied by Municipal Assembly in collaboration with Zoom Lion for residents in the study areas for waste storage. Approximately twelve (12) skips of $1.1m^3$ should be supplied in the towns to avoid dumping of waste in open spaces, gutters, backyards and roadside. These should be placed at least within 50 metres radius and at most 100 metres radius in the

residential areas. With this, residents will spend less time to dispose of their domestic waste at the skip site.

2. **Implementation of door-to-door waste collection services.** People should be encouraged to accept and pay for door-to-door waste collection and disposing services. This will go a long way to support the financing of solid waste management in the study areas. This can be done particularly, using tricycles to collect and transport the waste to the skips. This could reduce cost, ensure containment of waste generated, and could reduce indiscriminate disposal and littering in the towns.
3. **Regular collection of waste.** There should be regular conveyances of skips in all the study areas to avoid heaping of waste and over flowing of skips. Since the skips available are few and cannot be replaced as one is conveyed. At least, waste should be collected thrice a week in these areas and should be done in the evenings since majority of residences disposes their waste in the morning and traffic situation on the road in the area is minimal. Also, there should be regular monitoring of waste collection by the Municipal Assembly to ensure save sanitation and to promote public health.
4. **Use of efficient solid waste management methods.** The Integrated Solid Waste Management (ISWM) model could be adopted by the Municipal Assembly to ensure effective and efficient solid waste management in the areas. Residents should be educated and encouraged by Municipal Assembly, Zoom Lion Ghana Ltd and opinion leaders to separate their waste generated into their various components before final disposal. When the wastes are separated, plastics like polythene bags and water sachets, cans, bottles and metals can be recycled. Food waste can be composted for manure to boost agriculture. This will reduce the volume of waste to be disposed.

5. **Public education on sanitation and strict enforcement of sanitation laws.** There is a need to educate the residents on sanitation to widen their understanding on waste management issues. According to Mr. Richard Adam, the environmental health prosecutor of EJMA, twenty-six (26) people were prosecuted on sanitation related offences in the first quarter of 2013. This implies that, the people need to be sensitized on proper sanitation in the study areas. Intensive education of residents on waste management practices should be carried out in all the towns. Strict enforcement of sanitation bylaws should be ensured by the EJMA where administrative penalties for minor violations should be taken with urgency. The people in the study areas should develop proper attitudes and perception towards waste handling, which should be achieved through both formal and informal education. Community participation in waste management in the towns would influence their sense of responsibility towards their health and environment.

6. **Proper management of dumpsite.**

   The dump sites should be properly managed. Proper leachate management system should be instituted to avoid the possibility of waste polluting groundwater in the areas. Also, waste dumped in the dumpsites should be spread, compacted and cover with soil. This will prevent heaping of waste in the dumpsite. The dump sites management should ensure that, waste that is carried to the dump sites does not contain fire to spark burning and production of smoke. Waste collection sources should be checked to ensure that waste does not contain any fire. The waste management department should ensure routine monitoring of the dumpsites to check any eventual occurrences.

7. **Funding and collaboration for effective waste management.**

There should be effective collaboration between the waste management institutions in the study area especially between the waste management department and Zoom Lion Ghana Ltd. to ensure efficiency of services rendered in the study areas. The waste management department should be adequately resourced by the Municipal Assembly to ensure efficient and effective supervision and inspection of sanitary conditions in the study areas. The Municipal Assembly should source for funds from corporate institutions, non–governmental organizations and philanthropist to support waste management in the towns. Adequate funding of waste management in the areas will help procure adequate skips, dustbin, and core waste management equipment such as rolls on/roll off trucks, skip loaders and compaction trucks to promote effective waste collection and disposal.

Strategies to improve household solid waste management in the studied areas must take into consideration all the deficiencies identified with the view of increasing knowledge on health and the environmental implication of improper waste management among the populace. Work should also be done on waste quantification in different seasons to assess variations in quantities in each of the towns. It is hoped that these recommendations, when considered for action by the EJMA and the people themselves would help address the solid waste management challenges and its related issues in the three towns.

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APPENDIX

Research Questions

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

DEPARTMENT OF MATERIALS ENGINEERING

COLLEGE OF ENGINEERING

This questionnaire is designed for research on solid waste generation and management in Ejisu, Fumesua, and Kwamo in the Ejisu- Juabeng Municipality. The answers provided shall be treated with confidentiality.

Section A: Demographic Data

1. Name of respondent……
2. Gender: a. Male b. Female
3. Age (years): a. 18-25 b. 26-32 c. 33-36 d. 37-43 e. 44–50 f. > 51
4. Educational background: a. No formal education b. Elementary/primary education c. Junior Secondary School (JSS)/Middle School d. Senior Secondary School (SSS)/Ordinary Level e. Tertiary f. Others
5. How many people make up this household? State the number……
6. Give the composition; male…… Females……
7. Give the age ranges; males …… Females……
8. What job/ trade are you engaged in (the respondent)……

Section B: Attitudes and Perceptions of People

9. Who is responsible for cleaning your house and surroundings?

   a. The households within the house b. The district assembly c. Zoomlion

10. Do you think it is appropriate for individuals to clean their own surroundings? a. Yes b. No

11. Explain your answer: a. clean surroundings b. avoid the law c. personal hygiene d. as an ethical requirement e. disease prevention f. Avoidance of danger(attacks from wild animals)

12. Do you occasionally educate your household on the need to keep the surroundings clean? a. Yes b. No

13. If yes, what are some of the things you talk about during the education? a. clean surroundings b. avoid the law c. personal hygiene d. as an ethical requirement e. disease prevention f. Avoidance of danger (attacks from wild animals).

14. Where do you keep your refuse before disposal? a. baskets b. waste bins c. polythene bag d. a box e. waste bucket f. plastic/ metal pan g. other

15. Do you consider waste as a resource or a useless commodity? a. resource b. not useful

16. Do you sort your waste before disposal? a. Yes b. No.

17. What means of waste disposal do use? a. The use of district assembly facilities and services. b. The use of private contractors eg. Zoom Lion. c. Dumping in nearby bushes. d. Burning e. dumping in a pit f. open Dumps g. Others

18. Do you think the communal containers placed at vantage points to receive refuse is enough? a. Yes b. No

19. When in the day do you dispose off your waste? a. Morning b. afternoon c. evening d. anytime

20. Give time range if you dispose off your wastes in the morning.
    a. 4: 00 am - 5:00 am b. 6:00am - 7: 00 am c. 7:00 – 8: 00 am.

21. Who is responsible for the disposal of waste in the household? a. child b. adults c. others

22. The one responsible for waste disposal is he/she below 18 years? a. Yes b. No

23. If adult, give reasons for your answer. a. avoid danger b. Avoid being hurt c. avoid leaving refuse at unspecified places d. schooling

24. If child; give reasons. a. to save time b. tiredness c. duty of a child d. due to business f. other household chores g. others

25. Are all the children in the household attending school? a. Yes b. No

26. Do you think where the district assembly has located their waste bin is too far from your house?

    a. Yes b. No

27. At what distance would you have wished they placed the bins?

    a.100m b. 200m C. 300m d. 400m f. 500m e. others

28. How frequent do the waste collection agencies off load the waste from the wagons?

    a. Daily b. two days c. three days d. four days e. five days or more f. when it full

29. Do the wagons over flow? a. Yes b. No

30. If yes, how often? a. very often b. sometimes C. others

Section C: The People's Willingness to Pay for Indoor Waste Collection and Disposal Services

31. Do you wish your waste could be collected at your home? a. Yes b. No

32. Would you like to employ any waste collection agency, eg. Zoom lion to collect your refuse periodically from your house? a. Yes b. No

33. Give reasons. a. to save time b. they are expert c. consistent waste disposal

34. If No, give reasons. a. self-disposal b. re-use of waste c. cannot afford d. not reliable e. other

35. How much do you estimate to spend on the household in a day? Specify an amount GH¢…

36. How much do you spend on social events in a week? Specify an amount GH¢……

37. Are you able save some money in a Day/month? Give an estimate GH¢……

38. Do you think the amount paid for disposal at the communal containers is……

    a. too low b. too high c. enough

39. Do you think the payment should be based on quantification of the waste? a. Yes b. No 40. How much do you think you can pay to a waste collection agency monthly for emptying your waste bins in the house? Specify the amount, a. GH₵17 b.GH₵15 c.GH₵10 d.GH₵5

41. How much would you like to pay for daily collections of your refuse without providing you with waste bin? Specify the amount GH₵……

42. How often would you like your waste bins to be emptied should you employ a waste collection agency eg. Zoomlion. a. daily b. weekly c. others

Section D: Incentives and Suggestions for Waste Managements

43. Do you see the work of the waste management personnel to be efficient? a. Yes b. No

44. Would you offer any possible assistance for solid waste management in the town? eg. Communal labour, payment for waste disposal. a. Yes b. No

45. What are your suggestions for proper solid waste management in your town?

Questionnaire for the Municipal Assembly and Waste Collection Agencies

This questionnaire is designed to access for information on solid waste management in Ejisu, Fumesua and Kwamo. The answers provided shall be treated with confidentially.

Section A: Kinds and Adequacy of Waste Equipment and Personnel

1.

Equipment	Available Number	Optimum Number

2.

Description of Labour	Available Number of Staff	Optimum Number Needed

Section B: Incentives for Waste Management

3. Are you satisfied working in the sanitation unit? a. Yes b. No
4. Give reasons? …….
5. Do you have adequate protective clothing‟s and equipment‟s to aid you in your work? a. Yes b. No
6. What are the equipment and protective clothing‟s you lack? List ……
7. How much are you paid in a month? GH₵……
8. Do you think you are paid well for the work you do? a. Yes b. No
9. Do you get any allowances aside your salary? a. Yes b. No
10. Do you think you deserve allowances for the work you do a. Yes b. No
11. Specify the kind of allowances that should have been paid to you……..

Section C: Plans for Solid Waste Management

12. How does the district treat the solid waste?

a. Composting b. Converting into energy (electricity, fuel, gas, etc.) c. Recycling d. Landfill e. none of these

13. How often do you use each of these methods and on what scale?.....
14. Which of the following disposal methods do you use? a. Incineration b. open dump disposal c. Recycling d. Others
15. What are some of the problems resulting from the method / methods adapted?

16. Has the sanitation unit positioned waste bins along streets in the towns to receive refuse? a. Yes b. No

17. Give reasons? ……

18. Have you been receiving complaints about the amount the people pay for refuse disposal? a. Yes b. No

19. If yes, what are the complaints about? a. too high b. too low c. should be free

20. Have the people complained about the frequency of lifting of the communal containers? a. Yes b. No

22. If yes, how often do you lift the containers? State ……

23. Where is your landfill site located…….

24. What is the distance of the landfill site to settlements……

25. Do you think the site is properly sited……

26. Did the district do any site preparation and/ or engineering before usage a. Yes b. No

27. If no, give reasons……..

28 .Do you have a programme for leachate, Gas, and dust management a. Yes b. No

29. If no, give reasons……

30. Do you cover and /or compact the waste at the land fill site a. Yes b. No

31. If yes; how often do you cover and/ or compact the waste a. daily b. as when is needed c. immediately after disposal

32. Do the district assembly keep records on waste generation and disposal a. Yes b. No

33. If no, give reasons……

34. Have you fenced the landfill site? a. Yes b. No

35. Do you experience the activities of scavengers in the sites a. Yes b. No

36. What are some of the challenges encountered by the sanitation unit in handling solid waste in the district?.....

37. Do you have any educational programme on solid waste for the inhabitant in the district? a. Yes b. No

38. If No, give reasons for your answer……

39. Who funds wastes manage in the Municipality? State…….

40. What do you intend doing about these problems?.....

Waste Types, Quantity and Percentage Compositions in the study Areas

Towns	Ejisu		Fumesua		Kwamo	
Waste Types	Qty	%	Qty	%	Qty	%
Textiles	26.925	3.305466	5.5	1.20757	6.925	2.740621
Garden waste	33.775	4.14641	6.55	1.438107	10.675	4.224711
Batteries	10.075	1.236864	3.9	0.856277	2.6	1.028969

Food waste	327.7	40.23031	263.35	57.82066	97.475	38.57646
Paper	65.925	8.093326	13.55	2.975014	26.15	10.34906
Plastics	112.37	13.79518	43.7	9.594695	33.35	13.19851
Metals/ Cans	27.855	3.419638	13.5	2.964036	1.55	0.613424
Wood	31.955	3.922977	33.925	7.448514	6.35	2.51306
Glass	13.35	1.638922	2.3	0.504984	1.7	0.672788
Fruits, SeedS / Nuts	46.125	5.662566	10.3	2.26145	8.1	3.205636
Fine Residue(ash and sand)	118.5	14.54773	58.9	12.93198	57.8	22.87478
TOTAL	814.555		455.475		252.675	

Solid Waste Generation rate in the study Areas

Generation	EJISU	FOMESUA	KWAMO	Lsd	P-Value
Per household	1.0024 B	1.4795 A	0.9003 C	0.07425	0.0000
Per Capital	0.1989 B	0.2975 A	0.1937 B	0.09811	0.0000
Rate	58.182 A	32.533 B	18.100 C	0.07855	0.0000
Total Quantity	814.60 A	455.48 B	252.67 C	0.0803	0.0000